EW YORK FISH AND GAME JOURNAL

UME 6 JANUARY, 1959 NUMBER 1

POTENTIALITIES OF CERTAIN SPECIES OF WATERFOWL FOR MASS PRODUCTION[1]

Earl R. Holm Superintendent of Game Farms
New York State Conservation Department

Robert V. Bauer Assistant Game Farm Foreman
New York State Conservation Department

ABSTRACT

In connection with efforts to establish breeding populations in suitable at within the State, an investigation was begun in 1952 designed to develop production techniques for certain species of waterfowl that had previously raised in only small numbers in captivity. Principal emphasis was placed ntail and redhead but limited numbers of canvasbacks, gadwalls, shovellers blue-winged teal were also studied. Essentially wild stock, hatched from collected from wild-nesting birds, was obtained from the Delta Waterfowl rch Station at Delta, Manitoba, Canada. Also, eggs from the same source obtained for incubation studies.

The scope of the investigation included breeding, incubation, brooding earing, winter maintenance and nutrition. From 1952 to 1954 the work one at the Delmar Game Farm; after that, at the Howlands Island Game gement Area.

Various types of artificial nest facilities were provided for potential breeders, of these, wooden boxes set on posts over the water were the most accept- nd were used by both divers and dabblers.

Though these species are naturally monagamous, polygamous matings seem desirable for captive flocks.

Hybridization occurred and, therefore, it seems best to pen each species ately.

Pintails, gadwalls, redheads and canvasbacks will produce a substantial er of eggs in captivity.

Using artificial incubation techniques which had given satisfactory hatches llards, all species could be hatched successfully except redheads. When ad eggs were turned a full 180 degrees, hatches were satisfactory.

Brooding and rearing the ducklings presented no problems when the tech- s for mallards were used. A new type of duck brooder house is described.

All of the species studied were overwintered successfully without artificial r at temperatures as low as –30° F. when open water was maintained wintering pond.

This investigation was begun during 1952 and was the outgrowth proposed waterfowl stocking program that contemplated attempt- o establish breeding populations of various species of ducks on

ontribution (in part) of Federal Aid in Fish and Wildlife Restoration ect W-68-R.

State-developed small marshes and in suitable nesting habitat el where. It was designed primarily to develop mass production te niques for artificially propagating pintail, gadwall, redhead, canvasb and other species which are normally reared in captivity in relativ small numbers by only a few commercial producers or fanciers the country.

Ducks which might have been bred in captivity for many gene tions or which were of unknown origin did not seem desirable for s studies. Essentially wild birds were needed. The stock used v obtained through the co-operation of the Delta Waterfowl Resea Station at Delta, Manitoba, Canada, and the Canadian Wild Service. All had been hatched at Delta from eggs collected fr wild-nesting birds. Also, eggs from the same source were obtained incubation studies.

Due to the idiosyncrasies of ducks of these species, it was recogni that many problems would have to be solved. The basic techniq used had been developed for propagating a migratory strain of ga farm mallards for restocking the State's marshes, and in many instan mallards were used as controls in the studies. Some work was a included to compare game farm mallards with mallards hatch from eggs produced by wild birds. The latter were also obtained fr the Delta station.

The scope of the investigation included breeding, incubati brooding and rearing, winter maintenance, and nutrition. Thou the original project covered only the years 1952 and 1953, some aspe of the work were continued in subsequent years in order to further fine certain techniques; in fact, work on certain phases is still going

In setting up the studies, it was apparent that breeding behav as it influenced egg production, would present the most comp problems. This phase, therefore, was treated in greatest detail. exact nutritional requirements of the various species were unkno particularly the difference in requirement between diving ducks dabblers. The work done on this subject has been reported in anot paper (Holm and Scott, 1954).

In connection with artificial incubation, it was essential to le whether the environmental conditions that provided satisfactory hatc of mallards would serve for other species of dabblers and the dif ences, if any, in the requirements of the diving ducks. Since the incu tion period for the eggs of different species of ducks varies considera under natural conditions, due to weather and the length of time female is off the nest, it was necessary to attempt to determine

species studied the optimum incubation period that would produce most successful hatches of vigorous ducklings.

Job (1923) had demonstrated that wild ducklings of these species d be successfully brooded and reared under artificial conditions, these operations had been performed on a larger scale at the a Waterfowl Research Station. Therefore, it was not anticipated they would present any new problems. However, it was necessary letermine, under mass production methods: (1) whether all the ies would be compatable during the brooding and rearing period; whether different types of brooders are equally satisfactory; (3) ther the requirements of the diving ducks, particularly, are different ı those of the mallards. Some game breeders still recommend that icially propagated ducklings should not be permitted to enter water until they are at least 5 weeks of age (Rae, 1940, 1956). s contention was also considered.

Finally, in regard to winter maintenance, the need for housing /or artificial shelter during extremely low temperatures was studied.

The problems outlined in the foregoing were studied during the three years at the Delmar Game Farm near Albany. Due to the tations of space at that unit for handling large numbers of ducks, experimental stock was moved in December 1954 to the Howlands nd Game Management Area in Cayuga County and the remainder ne work was done there. The methods used and the results observed presented according to these major phases of the investigation.

BREEDING

Successful breeding and adequate egg production presented the t complex problems because, during the breeding season especially, species involved tend to have a low tolerance of game farm condi-s. Solving these problems was essential to successful mass pro-tion.

CRIPTION OF BREEDING PENS

A series of three artificial ponds at the Delmar Game Farm gure 1) in Albany County was used in connection with these lies. The lower pond contained 0.8 acre of water, with 2.2 acres and surrounding it making a total of 3.0 acres. This was divided a fence to provide two breeding pens (designated 1 and 2) with roximately equal land and water areas. The middle pond, con-ıting Pen 3, was separated from Pen 2 by a 4-foot fence along the rvening dyke and included a total area of 2.5 acres with 1.5 acres

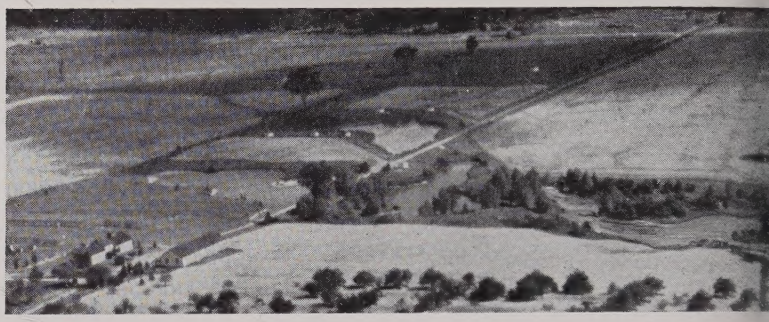


Figure 1. Series of ponds included in duck breeding pens at Delmar Ga Farm.

of land and 1.0 acre of water. The upper pond (Pen 4) totaled acres with 2.8 acres of land and 1.0 acre of water. Another nea pond comprising 0.5 acre of land and 0.5 acre of water was used Pen 5, and still another having 0.2 acre of land and 0.8 acre of wa constituted Pen 6. All pens were enclosed by 8-foot fences of pou netting.

A considerable variation in cover existed. The northern side Pens 1 and 2 included a 20-year-old stand of spruce with the balar in brush and brambles. The southern pond margin was brushy w a grassy meadow area to the fenceline. Pen 3 contained two sm islands in the pond. On one of these four small spruces provic cover, and a willow tree grew on the other. Twenty-year-old willo occupied a part of the pond margin with low brush making up balance. The upland area included grass and weeds. Pen 4 consis of old-meadow grasses overgrown with weeds. Pen 5 included a de stand of cattails in the pond with grassland to the fenceline. T pond in Pen 6 was roughly circular and bordered with brush and wee

Up to 600 mallard breeders had been confined in Pens 1 to 4 previous years and their egg production was excellent. Neverthel it was recognized that many of the species being studied are far adaptable to game farm conditions than is the mallard.

Thus the stage was set for the intensive preliminary observatio Based on these, quarters were provided at Howlands Island to m nearly meet the requirements of the breeding ducks. Here, an a of approximately 100 acres, including a large artificial pond, was closed by a fence of 8-foot poultry netting. The margin of the po had been previously cleared of brush and trees. After planting, cover comprised a mixture of grass and weeds. Board fences in

er separated the various species, while poultry netting 3 feet high he land confined the ducks to their assigned areas.

NING THE BREEDERS

During the first breeding season (1952) game farm mallards and mallards from Manitoba (designated "Delta" mallards) were pared with respect to egg production. Game farm birds of both s were placed in Pen 2; game farm females and Delta males in 3; and Delta birds of both sexes in Pen 4. All Delta stock prised first-generation birds from eggs collected in the wild. In

TABLE 1. ARRANGEMENT OF DUCKS IN BREEDING PENS IN 1952

n	Species	Number	
		Male	Female
	New York mallard	9	45
	Redhead	4	4
	Canvasback	..	3
	Pintail	2	2
	Gadwall	1	1
	New York mallard	9	45
	Redhead	4	4
	Pintail	2	2
	Gadwall	2	2
	New York mallard	..	45
	Delta mallard	14	..
	Redhead	4	4
	Pintail	2	2
	Gadwall	1	1
	Delta mallard	14	43
	Redhead	4	4
	Pintail	2	2
	Gadwall	1	1
	Redhead	13	15
	Pintail	1	1
	Shoveller	1	5
	Redhead	2	2
	Pintail	2	2

tion, breeders of the other species were distributed in various binations in these as well as the other pens. Another group of York mallards also occupied Pen 1.[2] The arrangement is shown able 1.

[2] e birds in Pens 1 and 2 were also used for nutrition studies (Holm and ott, 1954).

In 1953, in order to secure more specific data on compatab and the degree of hybridization that might be expected among species other than the mallard, various groupings of these spe only were made in the breeding pens. The 1-year-old redheads pintails were separated from the 2-year-olds so that any differe in egg production due to age might be determined. Thus: Pe contained both pintails and canvasbacks; Pen 2 contained gadw shovellers, and teal; Pen 3 contained 1-year-old females of redh and pintail; and Pen 4 contained 2-year-old redhead and pi females. Each pen included what was believed to be the neces complement of males for the females that were involved. Pe contained four female redheads and two males. This area inclu a rank growth of cattails and appeared to be the type of hab that might be utilized for natural nesting by this species. This arra ment is set forth in Table 2.

TABLE 2. ARRANGEMENT OF DUCKS IN BREEDING PENS IN 1953

Pen No.	Species	Generation in captivity	Age in years	Number	
				Male	Fem
1	Canvasback	F1	2	. .	
		F1	1	5	
	Pintail	F1	2	5	
		F1	1	4	1
2	Gadwall	F1	2	4	
		F1	1	2	
	Shoveller	F1	2	1	
		F1	1	7	
	Blue-winged teal	F1	1	7	
3	Redhead	F1	1	23	4
	Pintail	F2	1	13	1
4	Redhead	F1	2	11	2
		F2	1	5	
	Pintail	F1	2	8	1
5	Redhead	F1	1	2	

In order to segregate them effectively from game farm mall the Delta mallards were moved at the close of the first season

red holding pen at the White Game Farm in Genesee County. y were held there during the 1953 breeding season for nutritional ies and to obtain eggs for comparative incubation data.

Penning arrangements of the breeders after the first two years not been given because they did not follow any experimental gn.

RATIOS

From a practical standpoint the widest sex ratio that will pro- maximum fertility is the most efficient. Not only could feed be reduced as a result of holding a lesser number of drakes, the carrying capacity of the area for females might be increased. successful results had most often been secured by other workers n the various species were maintained in pairs.

Based on observations during 1952, it seemed desirable to use tio of one male to two females for the diving ducks and approxi- ely equal numbers for the dabblers. However, observations on vior during the following season indicated that a wider sex might provide better results.

The prenuptial behavior pattern indicated a strongly fixed ogamous disposition and the affinity between paired birds was defined. As the season progressed, though, polygamy became easingly evident. It was here that complications arose.

Among the redheads, many harems could be noted during loafing ods. More often than not, groups including one male and from to six females lazily paddled about the ponds as integrated m units. As an unattached drake approched a group, he seemed nse that he was intruding and would swim away without a break ride. No outward sign of hostility was observed either on the of the drake dominating the harem or the intruder. Rather, seemed to recognize his own rights and the position he occupied ne community. The potential intruder eventually rejoined a band achelor drakes where complete harmony appeared to exist at all s.

It is possible that, during such reconnaissance sorities, one or of the females in a large harem may detach themselves and the intruder. While this was not observed, the size of the bands continually changing. But, all this activity was conducted on ry casual basis with no evidence of friction among any of the ps of redheads in the pen.

The canvasbacks appeared to react similarly, but the numb under observation were small and the behavior pattern was no clear cut. This was in direct contrast to the situation among dabblers.

As the pintails represented the next largest group, they offe good opportunity for study. Their behavior was not unlike tha mallards in captivity. Like the redheads, they formed harems as season progressed. But unlike the redheads, intruders were n aggressive. The drake dominating a harem exhibited a defini possessive attitude. When an intruder was vanquished, the o drake majestically resumed his place in the harem—almost wit swagger.

Unlike the redheads and canvasbacks, the bachelor pintail dra were never at ease. Continual strife prevailed within the gro Invariably the lowest drake in the peck order suffered constant harr ment by the others. It was not uncommon to see one drake cha until he was driven into a corner. Here the other drakes would fi for their turn at treading. The low drake in the peck order inevita came out of it with few feathers on his head or back and contusi and abrasions. Where a large number of these "extra" drakes w present, mortality from this activity was high. But there was anot adverse effect caused by an excessive number of drakes whic more important.

In captivity it is necessary to maintain the breeder flock i flightless condition to prevent escape. When the polygamous tend cies became predominant, the males pursued and harrassed the fem until some females reached the point of exhaustion. Being flightl there was no escape from their pursuers. This undoubtedly produ an additional stress factor among these females that seems to h inhibited egg production. Further, penning the ducks in pair no guarantee of high fertility. Eleven female gadwalls occupied Pe with nine males, but all of the 45 eggs they produced were infer

For mass production, these studies demonstrated that for p tails a sex ratio of one male to not less than three females is n desirable than a narrower ratio. If fertility can be maintained a high level, a ratio of 1:4 or 1:5 might be optimum. This may h true for all of the species of dabbling ducks that were studied. the other hand, while a ratio of 1:2 caused no apparent difficul among the redheads or canvasbacks, it would be more practica attempt to approach a 1:5 ratio if fertility could be maintaine

RIDIZATION

In order to work out sound and practical techniques for the propagation of various species of ducks, it seemed necessary determine to what degree hybridization might occur.

During the first year, mallards were placed in four pens which ided redheads and pintails. A few ducks of other species were nt in these pens, too. In the second year, redheads and pintails combined in two pens, pintails and canvasbacks in one pen, gadwalls, shovellers, and blue-winged teal in one pen. In all, females and 97 males under observation during the second season. n one considers the number of possible combinations of matings might have occurred by chance, it is important to note that three instances were recorded.

A male blue-winged teal that escaped from Pen 2 constantly ided a female redhead in Pen 3. He was observed on many occa- waiting patiently near the nest box while she took time out to ier eggs. These eggs were all distinctively marked since hybridiza- was suspected. When they hatched, hybrids appeared.

In another instance, a series of redhead eggs from one female hed hybrids that appeared to be a typical redhead x pintail cross. During the same year one other case of hybridization occurred apparently was a shoveller x pintail cross, the eggs being pro- d by a full-winged shoveller that selected a nest site about 300 s from the pen in which others of her kind were confined.

The numerous observations of courtship and copulation between s and females of different species during the winter period might one to the conclusion that the ducks had promiscuous habits. ever, the gonads are dormant during this period. Whether cer- individuals are unable to recognize species differences at that time oject to speculation. But it is apparent that this recognition ability oves as sexual development progresses.

The fact that three cases of hybridization were recorded is of ient importance to rule out mixing species during the breeding n in a mass production operation. It should be noted, too, that unnatural conditions incident to artificial propagation may be ucive to interspecific matings. Were this not true, it would seem wild populations by now would have shown more evidence of idization than they do.

PATABILITY

No difficulties were experienced during the winter maintenance

period due to incompatability. All species were congenial. In the various species which were retained in a group in their wi quarters provided many hours of interesting observation when differences in habits and behavior could be readily noted. I wise, the different species appeared to tolerate each other v brought together in a common breeding pen. When one considers possibilities of hybridization, it might be said that they get a together too well. During the nesting season, though, certain flicts were noted.

A pintail had selected one of the artificial nest boxes on a p about 20 feet from the pond margin in which to deposit her e The proclivity of redheads to dump their eggs in any establi nest resulted in constant struggles with a redhead female for po sion of this nest. Apparently both birds had the urge to lay at appr mately the same time though the pintail usually occupied the first. The redhead did not hesitate to intrude, with a violent stru ensuing. Invariably, all the pintail eggs were cracked and some broken. Cracked pintail eggs were also found in other nests in same pen and it may be assumed that these resulted from sim conflicts.

An excessive number of males among the pintails resulted considerable degree of conflict. No evidence of strife was obse among the redheads, however.

While the various species are, in the main, compatible, confinement of mixed groups in breeding pens cannot be recommen in a mass production operation due to other factors which were cussed under hybridization.

Courtship

In captivity the same prenuptial displays have been observe those reported for these species as wild ducks on their native bree grounds (Hochbaum, 1944; McKinney, 1957). When still cont in winter quarters, mallards have been observed copulating as as December during occasional mild sunny days. With similar wea conditions early in January, a male pintail was seen courting a fe gadwall. Later in the month a pair of gadwalls, giving all appeara of being definitely mated, were observed for a long time. Both male and female of the pair drove off any intruding male gad that attempted courtship displays. During the same period, redh were courting. A few days later a male redhead was observed c

female gadwall. By the end of February, all species were observed ing except the blue-winged teal.

Redheads were first observed copulating during the third week in uary. While the gonads of these birds were not examined, those of er male nor female specimens which were killed at this season redators or by accident had shown any enlargement.

By mid-March the courtship displays, including copulation, in- ed in intensity. Therefore, March 15 was the date set as a rule umb to transfer the breeders from winter holding quarters to the ling pens.

ING FACILITIES

A successful and efficient artificial propagation operation for the production of waterfowl precludes the use of extensive areas of ral nesting cover for two reasons. First, the chore line involving ollection must be held to a minimum in order to maintain opera- l costs to a reasonable level. Extensive stands of natural nesting would require a methodical search of practically every square of the breeding pen area. At best, some eggs would not be located the female had started to incubate. In such instances, when the are set in incubators, the hatching dates vary. In addition, when nale has become broody, she usually will not renest and produce ional eggs. This appeared to be the case for the species studied. result is loss of at least one additional clutch that might have produced.

Second, where predation is a problem, as it was in these studies, ggs must be readily located and collected at regular intervals to losses to a minimum. Here, crows were probably first in impor- , but raccoons, opossums and foxes were not far behind in nest ation.

In order to reduce the chore line and minimize losses from pre- n, artificial nesting facilities were provided. It had been observed mallards that any break in the general cover pattern was usually n as a site for a nest. For example, a clump of goldenrod in a y meadow area was usually selected as was also a small conifer e lower branches touched the ground and whose over-all diameter ed only about 3 feet. A sparse clump of low brush was invariably A loose coil of barbed wire, that had been carelessly left in the ling pen some years before and that supported dead grass and ls from the previous season, was always chosen as a nest site. It

seemed apparent that, if given their choice, the ducks preferred a that was protected from overhead and from the rear and that h ready escape route from the front if the nest was disturbed. Four di ent types of nesting facilities were improvised to meet these req ments.

"A" Frames These were constructed of boards cut in len of 12 inches from which 12-inch squares were made up. Two squares were nailed together at a 60-degree angle. A 1- x 2-inch ba was nailed to the front and one to the back to make them rigid Fi 2). These "A" frames were placed about the field in a breeding pe

Figure 2. An A-frame artificial nest site

what appeared to be a random fashion but in a pattern that would vide a definite chore line from one to the other until the whole could be covered without back-tracking.

Tepees These were made up in the pen. Three sticks wer into the ground about 12 inches apart with their bases forming a angle. The tops were then brought together to form a tepee. This

red over with a piece of scrap poultry netting, either 1- or 2-inch , leaving only the front entrance open. The netting was pinned to ground with small twigs and the top of the tepee was covered with

Figure 3. A tepee artificial nest site.

grass or brush (Figure 3). These were established at intervals een the "A" frames and along the same route.

BRUSH PILES Small conifers 3 to 4 feet in height were cut and ed along the nest route. To increase the density and form a shel- area for a nest, a few branches were stripped off and laid over tt end which was faced toward the water.

Nesting sites of the foregoing types were established early in the g after the frost had gone out of the ground and while it was oft. A shallow depression in the earth was hammered out with st before the shelter was set up. This prevented the eggs from ning too widely separated in a nest if the ground was rough.

Boxes Nail kegs, inverted bushel baskets, and various typ boxes were commonly used as artificial nesting facilities for mall The construction of nest boxes specifically designed for ducks can costly item. From previous studies with mallards it was found they would accept a standard 12-quart whiskey case as well as anyt else. These, however, were hard to get, but a supply of beer cases found which could be used. After the inner separators were remo tops were nailed on and covered with roofing paper to make weatherproof. A 4-inch hole was cut in one end of each case a 4 inches up from the bottom. This afforded access to the nest and hole was high enough to prevent the eggs from rolling out (Figur

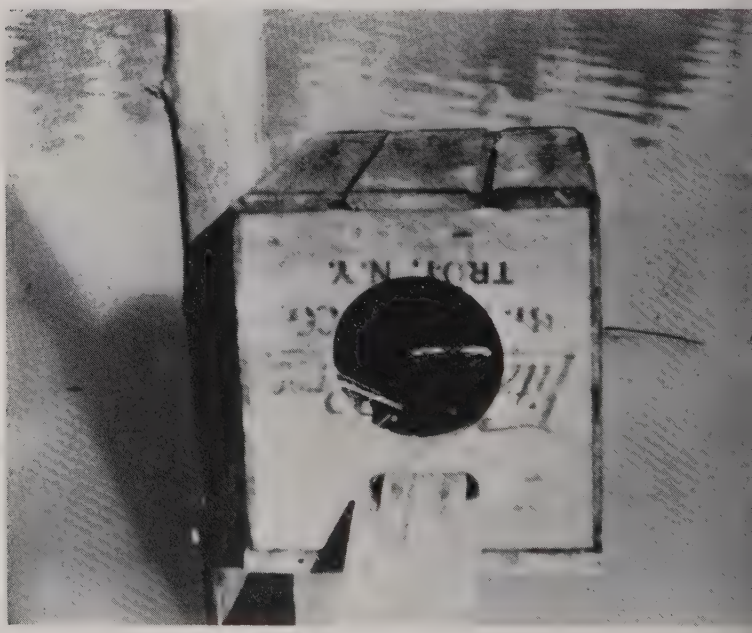


Figure 4. A beer case modified as a nest box.

A supply of range rearing coops was also available that had viously been used for hatching and rearing pheasants with don hens. They measured 2 feet square, 12 inches high in back, an inches high in front. Some were cut in half and rebuilt to make coops, each measuring 1 foot by 2 feet at the base (Figure 5).

The wooden boxes and coops were used in two ways. Some placed on the shore. The majority, however, were set up on

Figure 5. A range coop modified as a nest box

6. Nest boxes erected over water showing arrangement in relation to shore.

in the water like wood duck boxes. They were nailed to the posts a 12 inches above the water, and a cleated ramp from the entran the box or coop to the water level provided a walk so that the clipped ducks could have access to it (Figure 6).

The purpose of placing boxes over water was two-fold. It believed that it might reduce egg predation by crows, foxes, and sums. Also, such an arrangement might provide the over-water ty nest site usually selected by diving ducks such as the redhead canvasback.

Use of Artificial Nests

All the various types of artificial nesting facilities were acc by the ducks. Of the ground types, the tepees seemed to be us the greatest extent and they were the cheapest to provide. observations, based on loafing in the vicinity of the offshore box well as on the ramps leading to them, indicated that they might be ferred sites, and this proved to be the case. Periodic checks rev that more nesting material was being rearranged and formed in than in the artificial nest sites provided on land. The offshore

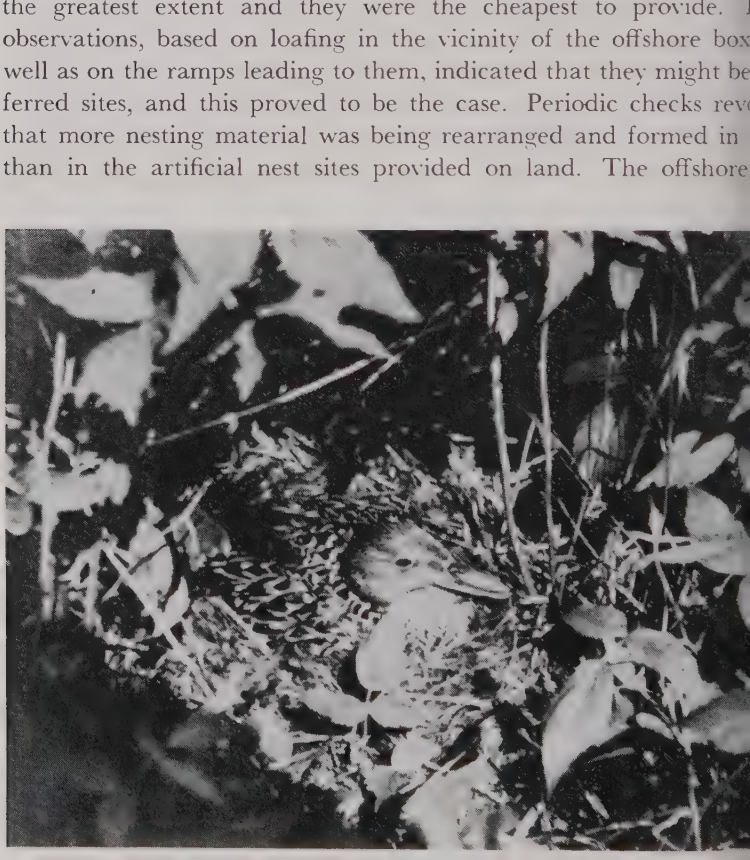


Figure 7. A pintail nesting in natural cover.

were numbered in order to obtain data on preference with re- to both the type of box and its location as well as exposure.

The first eggs of both pintails and redheads were laid in such and the canvasbacks used them exclusively. Throughout the n, the redheads appeared to prefer the offshore sites to any of acilities provided on shore.

While the dabbling ducks were inclined to range the upland area r widely in searching for suitable nest sites, the divers seldom ured more than a relatively few yards from the shoreline. In this ection, the pintails which chose nest sites on land usually occupied but occasionally formed their own nests in tall grass or other al cover (Figure 7).

The comparative use of offshore nest boxes and inland sites by rds in 1952 is shown in Table 3. There seemed to be no impor-

3. COMPARATIVE NUMBER OF MALLARD EGGS LAID IN NEST BOXES IN PONDS AND IN LAND NESTS IN PENS 2, 3, AND 4 IN 1952*

Pen No.	Eggs laid		
	Nest boxes in ponds	Land nests	Total
2	1,132	792	1,924
3	642	1,164	1,806
4	194	340	534
.....	1,968	2,296	4,264

*Arrangement of New York mallards and Delta mallards in these pens is given in Table 1.

difference in preference for nests sites, except that in Pen 3, the one having islands, most of the eggs produced were laid on the ds.

The number of eggs collected each week in 1953 from nest boxes e ponds and from nests on land in Pens 3 and 4 are compared able 4. Other groups are not considered because they laid too ggs.

These data bear out conclusions from earlier observations with ct to laying behavior. Band numbers were recorded for females g in boxes in the ponds. After their eggs were collected and the ostensibly broken up the majority continued to lay, but they ly moved to another similar box or to a location on land. In instances the collection of eggs caused an abrupt end of pro-

Table 4. Comparative Number of Duck Eggs Collected Each W from Nest Boxes in Ponds and from Nests on Land in F 3 and 4 in 1953

Week	Pintail		Redhead	
	Nest boxes in ponds	Land nests	Nest boxes in ponds	Land nests
1*	25	4	18	5
2	14	5	25	11
3	24	1	25	16
4	10	38	0	12
5	10	0	2	1
6	0	14	0	0
Number collected	71	71	71	45
Number destroyed by predators§	1	34	0	8
Total.....	72	105	71	53

* Figures for first week included all eggs collected from beginning of la season and represent a period of 14 days.
§ Date of laying unknown for these eggs.

duction. Pirnie (1935) also noted this reaction. The switch f nest boxes over water to land sites is clearly shown by the records the third and fourth weeks. The pintails, that laid 24 of 25 egg boxes in the ponds during the third week, relocated many of t nests and laid 38 of 48 eggs in nests on land the following week similar change took place with the redheads, although all of t nests in offshore boxes were abandoned during the fourth week.

The additional stresses caused by weekly breaking up the r resulted in confusion in the selection of subsequent nest sites. It therefore impossible to analyze the data to determine whether location, type, or exposure of an offshore nest box was importan relation to its degree of use.

Nest Predation

Where predators such as crows, foxes, raccoons, and opossu were prevalent, nest boxes in the ponds provided the greatest tection. At least 34 pintail eggs laid in nests on land were destro by predators. This represented 32.4 per cent of the total eggs recor for this species. Of these, 28 were in nests formed by the female natural cover. The number of additional eggs that may have b carried off by crows was unknown.

Raccoons accounted for some losses. In one instance a chalk egg
a box on land was so badly chewed it could hardly be identified
nest egg. The teeth marks of the raccoon were plainly visible.

PRODUCTION

From the data gathered during this study, the dates of the first and
eggs and period of peak production are presented in Table 5.
nar lies a little south of the 43rd parallel.

LE 5. DATES OF FIRST AND LAST EGGS AND PERIOD OF PEAK PRODUCTION FOR VARIOUS SPECIES OF DUCKS FROM 1952 TO 1954

Species	Date		Peak production
	First egg	Last egg	
ng ducks			
edhead	April 2	July 15	Second week in June
anvasback	April 18	June 27	Last week in May
bling ducks			
ntail	April 6	June 13	Mid-May
adwall	May 4	June 18	Last week in May
oveller	May 8	?	Mid-May

Nests were inspected periodically, but eggs were collected only
each week to avoid undue disturbance of the nesting females.
numbers of eggs produced by the various species are set forth in
les 6 and 7, including the records for these species after the stock
moved to Howlands Island.

Egg production for the different combinations of mallard breeders
lied in 1952 has been given in Table 3. The lower number laid
the first-generation birds from Delta indicates that there were
e factors that inhibited normal egg production among certain
viduals. Since it was estimated that only about half the Delta
ales laid eggs, this might reflect a greater degree of wildness than
of the New York game farm stock.

An effort was made to determine from the records for 1953
ther females which had been held in captivity for two years were
e productive than yearlings; likewise, whether birds of the second
eration in captivity were more productive than those of the first.
ause of the few eggs laid by the other species, data for the pintails
redheads only were used. The 13 second-generation 1-year-old
tails in Pen 3 laid 80 eggs for an average of 6.2 per female. The

Table 6. Comparative Egg Production Among the Diving Du Studied

Year	Number females	Eggs produced	
		Number	Average
Redhead			
1952	33	25	0.8
1953	82	124	1.5
1954	77	176	2.3
1955	77	816	10.6
1956	110	1,287	11.7
1957	192	1,341	7.0
1958	192	2,287	11.9
Canvasback			
1952	3	0	0.0
1953	11	24	2.2
1954	15	22	1.5
1955	17	32	1.9
1956	16	45	2.8
1957	21	78	3.7
1958	34	15	0.4

10 first-generation 2-year-olds in Pen 4 produced 75 eggs for an aver of 7.5. The first-generation 1-year-old females laid 42 eggs for average of 4.2.

Of the 124 eggs produced by the redheads, 116 were laid by 48 first-generation 1-year-old females in Pen 3. Only four eggs w collected in Pen 4 in which 28 first-generation 2-year-olds were c fined. In Pen 5, which included the most natural type of redh nesting cover that was available, four first-generation 1-year-old fem produced only four eggs.

It is difficult to interpret these findings for several reasons. Observations showed that only a portion of the females produced e From the band records, it was noted that several had laid two or th clutches during the season. It was suspected that others may h laid from 1 to 3 eggs before disturbance caused cessation of product Many of the other females showed no evidence of the enlarged ab men which is indicative of a producer. (2) The variation in type quality of nesting cover may have influenced the rate of produc in many birds. (3) Physiological stresses due to environment, as as stresses resulting from regular egg collections with the resul nest breakup, undoubtedly inhibited egg production in many poten producers.

E 7. COMPARATIVE EGG PRODUCTION AMONG THE DABBLING DUCKS STUDIED

Year	Number females	Eggs produced	
		Number	Average
New York mallard			
1952	135	5,408	40 1
Delta mallard			
1952	43	534	12.4
1953	59	385	6.5
Pintail			
1952	11	57	5.2
1953	33	197	6.0
1954	81	336	4.1
1955	145	117	0.8
1956	145	373	2.6
1957	150	97	0.6
1958	100	373	3.7
Gadwall			
1952	5	0	0.0
1953	11	45	4.1
1954	8	77	9.6
1955	6	8	1.3
1956	4	42	10.5
1957	7	66	9.4
1958	7	101	14.4
Shoveller			
1952	5	0	0.0
1953	7	12	1.7
1954	8	31	3.9
1955	7	0	0.0
1956	6	30	5.0
1957	16	40	2.5
1958	15	119	7.9
Blue-winged teal			
1953	6	36	6.0

While the redheads began production, on the average, about eks after the pintails, many were noted forming their nests early pril. However, few, if any, eggs were laid by these individuals. period of nest activity subsided after a few days, and an interval pproximately 2 weeks elapsed before these manifestations were

again observed. Thus, the period during which a potential first cl of eggs might have been produced passed by. Post mortem exam tion of a number of birds killed by predation during this early pe disclosed that the ovaries were well developed and in some cases female should have ovulated within a day or two. However, egg duction did not occur at that time. Other females examined from same flock at a later date showed definite evidence that the ov were atrophic. It seems apparent that there was sufficient stim to cause normal development of the ovaries at an early date, environmental stresses and/or disturbance resulted in resorbtio the ova. This would account for the pattern of laying where ce individuals produced no eggs, a few produced from one to four, w others, more resistant to these stresses, completed one or more clutches during the laying season. This behavior pattern was like noted to a lesser extent among the pintails studied.

INCUBATION

The incubation studies carried on had a two-fold objective: to determine the optimum conditions for incubating eggs of sp other than the mallard; (2) to determine the incubation perio eggs of various species of waterfowl under controlled conditio

Because of the greater value of the eggs of the species stu compared with those of the mallard, domestic hens are commonly for incubation with satisfactory results. Such operations, how have been on a small scale. Of course, female ducks of these sp when permitted to incubate on completion of a clutch, are usual successful in hatching in captivity as native birds in the wild. versely, use of incubators heretofore has largely been limited to ha ing eggs collected on the breeding grounds from nests which been partially incubated before they were collected. When pro handled such eggs hatch remarkably well in incubators (Job, 1923; Hochbaum, 1944). But little work had been done on arti incubation using incubators exclusively for hatching eggs prod from birds held in captivity.

Types of Incubators

In the initial studies two types of incubators were used. was a sectional still-air machine electrically heated and thermo cally controlled, with each section having a capacity of approxim 100 eggs. The other was a larger type of agitated-air machine w

Figure 8. Two models of agitated-air incubators.

ommonly used by commercial duck hatcheries. This unit had a ng capacity of 6,600 eggs, and a hatching capacity of 2,250 eggs separate agitated-air hatcher (Figure 8).

In 1957 and 1958 agitated-air incubators and hatchers of smaller city were used.

As there were sufficient mallard eggs available, these were used ontrols in studying the eggs of other species. Eggs were collected stored in accordance with approved practices (Romanoff, Bump Holm, 1938). All incubators were operated in accordance with niques that had been worked out to furnish the greatest hatch- ty of mallard eggs.

In 1952 the majority of eggs incubated were produced by breeders he regular New York mallard strain. Their hatchability was pared with that of eggs laid by first-generation Delta mallards. tively few eggs were produced by the redheads and pintails which been retained for breeders. The hatchability of the eggs set from ive breeders in 1952 is set forth in Table 8.

In order to secure additional data relative to comparative hatcha- and to test the feasibility of transporting pre-incubated eggs

TABLE 8. HATCHABILITY OF DUCK EGGS FROM CAPTIVE BREEDERS INCUBA ARTIFICIALLY IN 1952

Species	Number eggs set		Eggs hatched	
	Total	Fertile	Number	Per c
Diving ducks				
Redhead	25	15	11	73.
Dabbling ducks				
New York mallard	3,455*	3,192	2,107	66.
Delta mallard	529	465	304	65.
Pintail	40	32	30	93.

* Eggs from New York mallard females bred by Delta drakes not inclu

TABLE 9. HATCHABILITY OF DUCK EGGS, FROM WILD BREEDERS, INCUBA ARTIFICIALLY IN 1952*

Species	Number fertile eggs set	Eggs hatched	
		Number	Per co
Diving ducks			
Redhead	443	108	24.4
Canvasback	48	19	39.6
Ruddy duck	13	12	92.3
Golden-eye	8	2	25.0
Scaup	7	2	28.6
Ring-necked duck	?	4	....
Dabbling ducks			
Delta mallard	174	96	55.2
Blue-winged teal	92	66	71.7
Pintail	79	28	35.4
Shoveller	39	26	66.7
Gadwall	25	16	64.0
Baldpate	?	2	....
Unknown	108	..	....

* Eggs collected from wild nests in Manitoba; incubation begun at I Waterfowl Research Station and completed after transportation of to Delmar Game Farm.

from the native breeding grounds, a portable, agitated-air incub was designed and constructed to accommodate 1,200 duck eggs. fan, heating elements and thermostatic controls were designed operate on the 15-volt direct-current circuit of the Departme airplane which was used for transportation. A transformer rectifier were built in so the incubator would also operate on volt alternating current.

A total of 1,036 fertile pre-incubated eggs were transferred from ncubators at the Delta Waterfowl Research Station to the porta- machine during the summer of 1952. These were flown to the ny Airport with only one short stop for refueling. There the bator was transferred to a waiting station wagon and transported ne Delmar Game Farm where the eggs were placed in regular bators. Several eggs hatched en route and one redhead duckling completely dried off on arrival.

The numbers of eggs of each species as they were recorded at a and the proportion that hatched are shown in Table 9. The t similarity of certain eggs of some species presented a problem positive identification; 108 eggs were unidentified, and a few lings hatched that were of species not on inventory. While it impossible to secure fully accurate percentage figures for hatcha- by species, it ranged from a high of 92.3 per cent for ruddy s to a low of 24.4 per cent for redheads among the divers, and 71.7 per cent for blue-winged teal to 35.4 per cent for pintails ng the dabblers.

In 1953 all the eggs set were produced by first- and second- ration breeders. The results of incubation are shown in Table 10.

E 10. HATCHABILITY OF DUCK EGGS, FROM CAPTIVE BREEDERS, INCUBATED ARTIFICIALLY IN 1953

Species	Number eggs set		Eggs hatched	
	Total	Fertile	Number	Per cent
ng ducks				
dhead	96	89	29	32.6
nvasback	23	7	6	85.7
bling ducks				
lta mallard	362	299	193	64.5
ntail	129	100	70	70.0
dwall	22	0	0	0.0
oveller	12	7	2	28.6
ue-winged teal	32	13	10	76.9

It was apparent that eggs from both pintails and teal are easy ncubate and that their hatchability exceeded that of the mallard

The canvasback eggs likewise hatched well, but the number lved was so small that it was difficult to draw any definite con- ons. From examination of the size, shape, and shell texture

of the canvasback eggs, it appeared that all that hatched were f the same female, the other clutches all being infertile.

It was definitely determined that the redhead eggs requ different incubating conditions than mallard eggs. They were stu carefully during the process of incubation in order to check em onic development and to determine at what stage the developm became retarded with resulting embryonic mortality prior to hatch All eggs were candled at regular intervals and it was noted, part larly among the redhead eggs, that development did not prog normally after about the 8th day. The factor or factors respon for abnormal development in the redhead eggs were not determi The symptoms, though, were similar to those previously obse on occasions when poor hatches of mallard eggs had been encounte In these instances, too, development of the embryos apparently gressed normally to sometime between the 8th and 10th days w it could be observed that the allantois was not developing in acc ance with the normal pattern. In cases where the allantois complete in the redhead eggs by the 13th day, practically all of t eggs hatched. However in others, as the incubation period progre the condition became more severe. It could be readily observed the allantois retrogressed though the embryo continued its gro

The incubation records for the experimental stock after it transferred to Howlands Island are given in Tables 11 and 12.

Table 11. Hatchability of Diving Duck Eggs, from Captive Breed Incubated Artificially in Years 1954 to 1958

Year	Number eggs set		Eggs hatched	
	Total	Fertile	Number	Per cen
		Redhead		
1954	131	120	5	4.2
1955	729	627	104	16.6
1956	1,131	1,046	298	28.5
1957	1,296	1,134	592	52.2
1958	2,058	1,850	1,500	81.1
		Canvasback		
1954	22	18	5	27.8
1955	32	1	1	100.0
1956	45	44	29	65.9
1957	76	57	33	57.9
1958	14	14	12	85.7

E 12. HATCHABILITY OF DABBLING DUCK EGGS, FROM CAPTIVE BREEDERS, INCUBATED ARTIFICIALLY IN YEARS 1954 TO 1958

ear	Number eggs set		Eggs hatched	
	Total	Fertile	Number	Per cent
		Pintail		
)54	287	235	115	48.9
)55*	0	..	..	....
)56	305	250	140	56.0
)57	91	72	60	83.3
)58	332	301	246	81.7
		Gadwall		
)54	48	17	9	52.9
)55§	0	..	..	....
)56	42	25	18	72.0
)57	66	33	24	72.7
)58	84	84	73	86.9
		Shoveller		
)54	23	22	8	36.4
)56	30	30	25	83.3
)57	40	35	31	88.6
)58	99	92	58	63.0
		Blue-winged teal		
)54	9	9	8	88.9

All eggs laid incubated by females; 105 of 117 hatched.
All eggs laid destroyed in nest by predator.

ECT OF 180-DEGREE TURNING

It was apparent in 1953 that further studies would have to be rtaken to determine the proper conditions for incubating red- l eggs. But proper equipment and facilities for controlled studies not available until 1957. During that year, studies were con- ed to determine whether 180-degree turning would influence hability as demonstrated for domestic goose eggs (Randles, 1947). ll, 1,341 redhead eggs were produced. From these, equal numbers n each day's collection were trayed separately and set at weekly rvals in two identical agitated-air incubators. Temperature, idity, ventilation, cooling period, and sprinkling were the same oth machines. However, in one unit the trayed eggs were turned conventional 90 degrees, while in the other they were turned mplete 180 degrees. Eggs from both units were transferred to an ated-air hatcher at hatching time to provide uniform conditions

Table 13. Hatchability of Redhead Eggs Incubated in Trays Tur 90 Degrees Compared with That in Trays Turned Degrees

Hatch No.	90-degree turn			180-degree turn		
	Number fertile eggs set	Eggs hatched		Number fertile eggs set	Eggs hatched	
		Number	Per cent		Number	Per ce
2	13	5	38.5	12	10	83.
3	16	7	43.8	15	10	66
4	47	9	19.2	50	30	60.
5	59	19	32.2	86	65	75
6	96	34	35.4	73	53	72
7	142	36	25.4	63	46	73
Total...	373	110	29.5	299	214	71.

until the ducklings emerged. Of 373 fertile eggs turned 90 degr 29.5 per cent hatched; of 299 fertile eggs turned 180 degrees, 7 per cent hatched (Table 13). In 1958, all of the redhead eggs w turned 180 degrees and an average hatchability of 81.1 per cen the fertile eggs resulted (Table 11).

Incubation Period

There seems to be little agreement on the actual incubation peri of the eggs of various species of ducks (Bent 1923, 1925; Hochbau 1944). This is understandable, since weather and the length of ti an incubating duck is off her nest will influence the duration of cubation. When there is a need to hatch large numbers of eggs of various species artificially, it is essential to know precisely the b incubation period for each so that optimum temperatures may maintained to secure maximum hatchability.

When the incubators were operated to hatch mallard eggs in days, the average incubation periods for the other species were det mined as follows:

pintail	22½ - 23 days
blue-winged teal	21 days
redhead	25 days
canvasback	26 - 27 days

Peter Ward, hatchery manager at the Delta station, has sta that their experience indicates the incubation periods for these spec to be from 1 to 2 days less than this. On the other hand, three s tings of redhead eggs, placed under bantam hens and set simultaneou

those in incubators, hatched in 25 days. There were five eggs ach setting, all were fertile and all hatched. Though this sample small, the results indicate that a 25-day incubation period for ead eggs approaches the optimum.

Because of the limited numbers of eggs produced by other species, as impossible to determine the optimum incubation periods for ı.

BROODING AND REARING

It has been demonstrated by numerous workers over the past 30) years that ducklings of species like the pintail, gadwall, shoveller, pate, and teal, as well as the redhead, canvasback and other divers, l be successfully brooded and reared with little difficulty. In all arly attempts at rearing, common domestic hens were used as foster ers. Job (1915, 1923), however, disproved the theory that these s could be hatched and reared only by using domestic hens when ade his early expedition into the Northwest and set up a rearing n in the Province of Manitoba. There, he not only hatched wild- cted eggs in incubators, but he also reared to maturity under ly artificial conditions all of the species common to the area. y of these ducks were furnished to other workers in the States were engaged in small-scale waterfowl propagation projects, but survived long. While there was some reproduction, the limiting rs proved to be malnutrition, disease and accidents. Delacour 6) also cited many early records of the successful propagation ese species.

But Foster Parker was among the first in the East who was able crease the size of his flock consistently from year to year. His an ideal location on the banks of a backwater of the abandoned Canal in central New York. On my many visits with him during arly 1930's we spent many enjoyable hours discussing the limi- ns of waterfowl propagation. He used domestic hens exclusively ncubation and for brooding and rearing his ducklings. The lawn ont of his house was his rearing field. The coops confining the were scattered about in an irregular fashion, one with a brood nvasbacks, several with wood ducks, and others with redheads baldpates. He attributed his success largely to his feeding pro- which included angleworms and such items as chopped raw y or liver, as well as other meats which were added to a ration ncluded meal, greens and sieved hard-boiled eggs.

More recently, the Delta Waterfowl Research Station has raised

ducklings by the hundreds. All were started in small lots in v floored brooders similar to battery brooders, with an electric bulb as a source of heat. They were later transfered to floor broo of the conventional continuous hot-water type and were run on a concrete floor with a low wire platform under the brooder to imp sanitary conditions. Shallow water troughs ran the length of pen giving the ducklings an opportunity for swimming. The f were hosed daily. The ducklings were later placed in a large v covered enclosure to complete their development.

But in spite of the successful results of many of these experim rearing projects, several theories relative to nutrition, behavior management required study to determine their validity. Among t was the belief that some, if not all, of these species require a protein diet. It has been reported previously (Holm and Scott, 19 that a diet suitable for domestic ducks produced satisfactory gr for the species studied. It has been suggested, too, that certain o species, such as the canvasback, were incompatible when brooded other species. Also, many workers have contended that the duck would die if they were permitted to enter the water at an early

Figure 9. Portion of pheasant nursery modified for brooding ducks sho water trough and movable partitions.

The objectives of this study, therefore, were to determine whether species require special management techniques for brooding and ing that differ from those commonly employed in producing ards.

During the first two years, brooding studies were conducted in wing of the pheasant nursery having a floor area of 28 by 40 feet which had been partly modified as a duck house with a full-length r trough. Movable partitions were provided for pens so that the ding area could be adjusted to the number of ducklings in each (Figure 9).

Two types of electric brooders were used. A conventional brooder, ches in diameter, was used for the larger lots of 100 to 200 duck- (Figure 10), while infrared heat lamps served as the source of cial heat for smaller lots of from 20 to 50 ducklings per lamp ure 11). Also, a brooder of the conventional type, but heated by ed gas, was used in a colony brooder house located near the ng ponds. All were satisfactory. The floor beneath the brooders

e 10. Conventional electric brooder with day-old ducklings on muslin sheet confined by hover guard of corrugated paper.

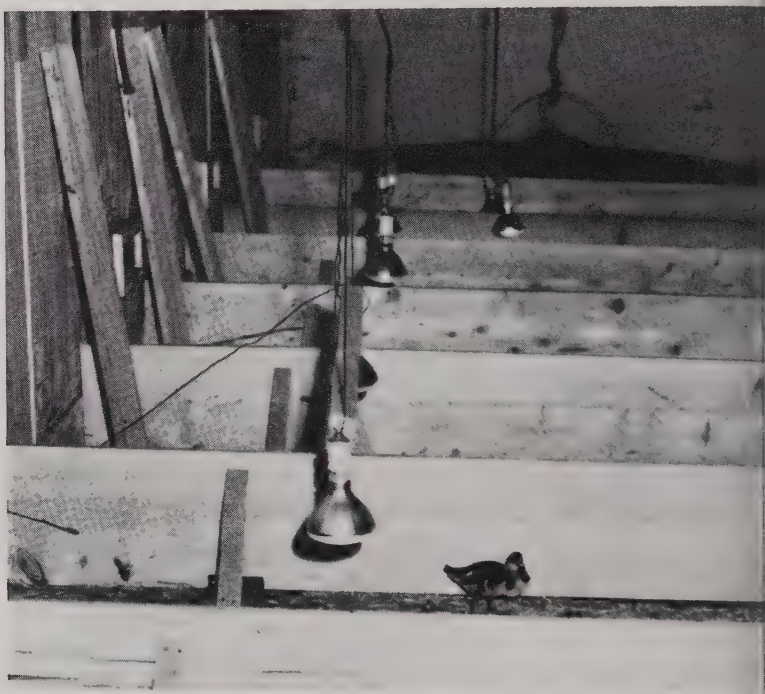


Figure 11. Arrangement of infrared heat lamps used for brooding small n bers of ducklings.

was covered to a depth of 2 inches with a sugar cane litter which changed daily.

Management practices were followed which had been used cessfully in the production of mallards. Since mallards hatched earl the first lots of ducklings consisted of these only. Subsequent hat consisted of pintails, gadwalls, redheads, canvasbacks and a few d lings of other species. At the start all the ducklings were broode mixed lots. It was noted that the canvasbacks appeared to be n nervous than the other ducklings and seemed to have a wilder position. They were perfectly compatible, though, and no difficu were encountered.

On occasions when relatively few ducks hatched at a given t two age classes were combined in one pen in order to save sp Where the difference in age did not exceed 3 or 4 days no difficu were encountered. On the other hand, a tiny blue-winged teal esc

ugh a crack in the partition to the adjoining pen of older ducklings re it was subsequently found picked to death.

As each new lot of ducklings came from the incubators, they e placed under an electric brooder on a muslin sheet which cov- the litter. Food and water were available at all times. A cor- ted paper guard 18 inches high encircled the brooder to confine ducklings to the source of heat for the first few days (Figure 10). ally on the second or third day the guard was opened so the duck- s had access to the water in the trough for swimming. Several were placed in the water immediately after being taken from the bators and subsequently driven under the brooder to dry out. No ffects were noted and they apparently enjoyed it thoroughly.

The corrugated paper guard was removed as soon as the ducklings me accustomed to the source of heat. The pattern of activity wed a definite routine. They would swim and eat and, when l or cold, would scamper for the warmth of the brooder. After riod of preening and drying out, the procedure was repeated. The n became quite well oiled after only a relatively few days due to frequent preening. After that the ducklings spent a greater amount me in the water swimming, diving and chasing.

TABLE 14. DUCK BROODING SUCCESS IN 1952

Species	Number started in brooders			Reared to 5 weeks	
	From project stock	From Delta*	Total	Number	Per cent
ng ducks					
edhead	11	153	164	158	96.3
anvasback	0	53	53	34	64.2
bling ducks					
ew York mallard	2,795	...	2,795†	2,777	99.4
elta mallard	304	288	592	382	64.5
intail	30	113	143	116	81.1
adwall	0	35	35	11	31.4
ioveller	0	45	45	31	68.9
lue-winged teal	0	66	66	28	42.4
cellaneous§	..	22	22	7	31.8

Included day-old ducklings that had been hatched from wild eggs at Delta and transferred to Delmar, in addition to the ducklings hatched as shown in Table 9.

Comprised a few ducklings of other species as shown in Table 9.

Includes ducklings hatched from eggs produced by New York mallard females and Delta drakes.

TABLE 15. DUCK BROODING SUCCESS IN 1953

Species	Number started in brooders			Reared to 5 w	
	From project stock	From Delta*	Total	Number	Per
Diving ducks					
Redhead	29	39	68	47	69
Canvasback	6	23	29	27	93
Dabbling ducks					
Delta mallard	193	71	264	211	79
Pintail	75§	7	82	62	75
Shoveller	2	0	2	0	0
Blue-winged teal	14†	0	14	7	50

* Day-old ducklings that had been hatched from wild eggs at Delta transported to Delmar.
§ Includes five ducklings hatched by female.
† Includes four ducklings hatched by female.

TABLE 16. BROODING SUCCESS FOR DUCKLINGS FROM CAPTIVE DIVING D FROM 1954 TO 1958

Year	Number started in brooder	Reared to 5 weeks	
		Number	Per cent
	Redhead		
1954	5	5	100.0
1955	136*	106	77.9
1956	276	274	99.3
1957	592	577	97.5
1958	1,500	1,459	97.3
	Canvasback		
1954	5	4	80.0
1955	1	0	0.0
1956	29	28	96.6
1957	33	31	93.9
1958	12	11	91.7

* Includes 32 ducklings hatched by females.

The results of brooding for the first two years are given in T 14 and 15. In both years day-old ducklings of several species obtained from the Delta station in addition to the pre-incubated also obtained from that source. The ducklings were transp by air and rail. Brooding records for the years after the experim stock was moved to Howlands Island are given in Tables 16 an

LE 17. BROODING SUCCESS FOR DUCKLINGS FROM CAPTIVE DABBLING DUCKS FROM 1954 TO 1958

Year	Number started in brooder	Reared to 5 weeks	
		Number	Per cent
	Pintail		
1954	208§	180	86.5
1955*	0	...	....
1956	140	127	90.7
1957	156†	152	97.4
1958	246	244	99.2
	Gadwall		
1954	9	5	55.6
1956	18	18	100.0
1957	24	21	87.5
1958	73	70	95.9
	Shoveller		
1954	8	6	75.0
1956	25	22	88.0
1957	31	30	96.8
1958	58	51	87.9
	Blue-winged teal		
1954	8	6	75.0

Of 105 ducklings hatched and brooded by females, 73 were reared to 5 weeks.
Includes 96 day-old ducklings transferred from Delta.
Includes 93 day-old ducklings transferred from Delta.

In 1952, of all of the ducklings that were lost, the vast majority cumbed to so-called unavoidable accidents. On one occasion, the rflow pipe in the trough became clogged and a portion of the floor s flooded which resulted in the loss of almost all those in one pen m chilling. On another occasion, when the trough was drained for aning by an inexperienced attendant, a number of ducklings escaped m their pen, fell into the trough and were sucked down the drain e. On another occasion, when the trough was being refilled, another up of ducklings escaped, fell into it, became exhausted and drowned their frantic attempts to get out.,

In order to eliminate or at least reduce accidents of this type, new duck brooder house was designed for economical mass pro- tion. Because of our belief that early access to the water is essen- for the good growth and development of ducklings, the house

was located on the edge of a pond and constructed partly over water.

The front of the house, over the water, was supported on c crete piers spaced 6 feet on centers. The water area inside the h was 7½ feet wide by 2½ feet deep and extended the full length the building. Removable wire screens between the piers on the side confined the ducklings to the house. Similar screens in the w inside provided pens that were 6 feet, or multiples of 6 feet, in wi The house measured 22 feet in width inside. The floor had a s of 1 inch to 12 feet from the back toward the water. A ramp a pitch of 1 foot in 3 feet provided easy access to the water for ducklings. The water level in the pond was maintained at a p midway up the ramp. Thus, the floor level in the house was 6 in above the normal water level of the pond. Removable partitions inches high confined the ducklings to their respective groups. Fig 12 illustrates the interior arrangement. This height readily held species up to 3 weeks of age except young wood ducks which sc

Figure 12. Interior view of new duck brooder house constructed partly water.

-type duck brooder house during construction and after pond was flooded.

boards and roamed at will from pen to pen. A plank catwalk was on top of the partitions and extended the length of the building. of the feeders could be serviced from this walk. It eliminated most ne need for walking in the pens and reduced the hazard of stepping he young ducklings.

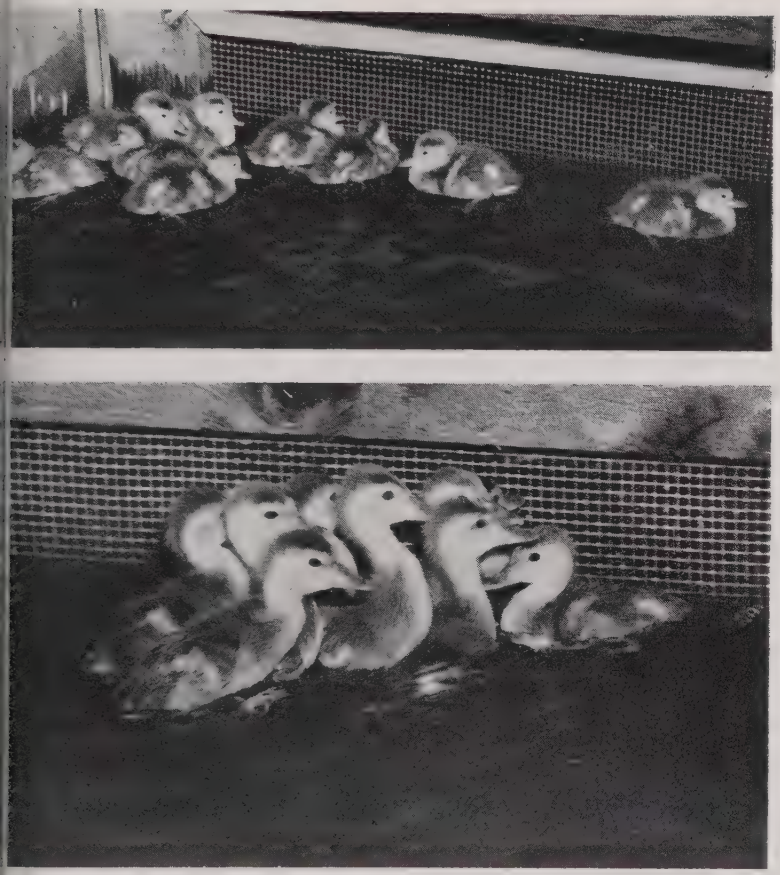
In recent years infrared heat lamps have been used exclusively

for brooding. For small hatches of up to 50 ducklings, a single was used. For lots of up to 225, a cluster of four bulbs was used two of them being controlled by a thermostat.

The heat lamps offer several important advantages. Among t is the fact that all of the ducks may be observed at all times and that are abnormal may be readily seen. On the other hand, with conventional canopy-type brooder, it was necessary to raise the w unit in order to make observations. This resulted in undue disturba of the ducklings and they invariably scattered and panicked. C versely, those brooded under heat lamps were more tractable easier to handle. Quite frequently there was a moisture problem u the conventional brooder. This was eliminated with the heat la as the litter was quickly dried out while the ducklings were indul in a swim.

During the normal course of brooding operations the duckl were confined to the house for the first 3 weeks only. Since hat were scheduled at weekly intervals, each lot that was started was pl in a pen at one end of the building. The group was moved pro sively toward the other end on successive weeks so that at end of the third week they could be driven outside into the firs a series of rearing pens that adjoined the building there. Thus a duction-line schedule was provided whereby the pen or pens occu by the 3-week-old ducklings could be cleaned and refurnished with litter to accommodate the next group which would be 2 weeks of a that time. Under this arrangement the screens separating the in the water were removed and the ducklings were casually drive the next pen down the line where clean quarters had been prep for them. There was no need to catch or handle them at any during the course of these operations.

The problems of cleaning and sanitation were minimized this arrangement. All feeders were placed on the concrete flo the top of the ramp and adjacent to the servicing catwalk. Any s amount of feed that was wasted from the hoppers was washed d from time to time into the water. Small minnows which made way through the ½-inch-mesh wire screening apparently cleane this waste feed as it settled to the bottom. Because the ducklings s so much time in the water, most of the droppings went into the w The result was that the litter in the pen was relatively clean a end of a week's time. Droppings which had settled to the botto well as some silt which was deposited from the pond were re



Two groups of baby ducks: (above) redheads; (below) canvasbacks.

ned out with a suction pump working on the principle of a vacuum ner. This was discharged outside the building.

The first unit of this type was built at Delmar, and a second one, lified only slightly, was built later at Howlands Island. This unit the manner of handling the birds described was used for the brood- experiments in 1957 and 1958. Brooding ducklings under these ditions, where they had access to water at all times, seemed to pro- e a hardier and more vigorous bird. In spite of the fact that feed before them at all times, the ducklings maintained their natural formation without depositing any excessive fat. It is believed the conditions provided approached the optimum and that this eflected in the excellent rate of survival as presented in Table 18.

TABLE 18. DUCK BROODING AND REARING SUCCESS IN 1957

Species	Number started in brooders	Reared to 3 weeks*		Reared to 5 weeks	
		Number	Per cent	Number	Per c
Diving ducks					
Redhead	592	581	98.1	577	99
Canvasback	33	31	93.9	31	100
Dabbling ducks					
New York mallard†	291	290	99.7	290	100
Pintail	156	153	98.1	152	99
Gadwall	24	21	87.5	21	100
Shoveller	31	30	96.8	30	100

* Represents period in specially designed duck brooder house.
§ Percentage of those reared to 3 weeks.
† Sample lot included for comparison.

With proper brooding conditions and an adequate diet, du lings reared to 3 weeks of age may be considered well on their wa maturity. When the ducklings reached this age, the screen was remo from the end of the building and they were allowed to swim out into the first of a series of rearing pens (Figure 13). They were mo to progressively larger areas each week until they reached the ag 6 weeks when all age classes were combined on the main pond.

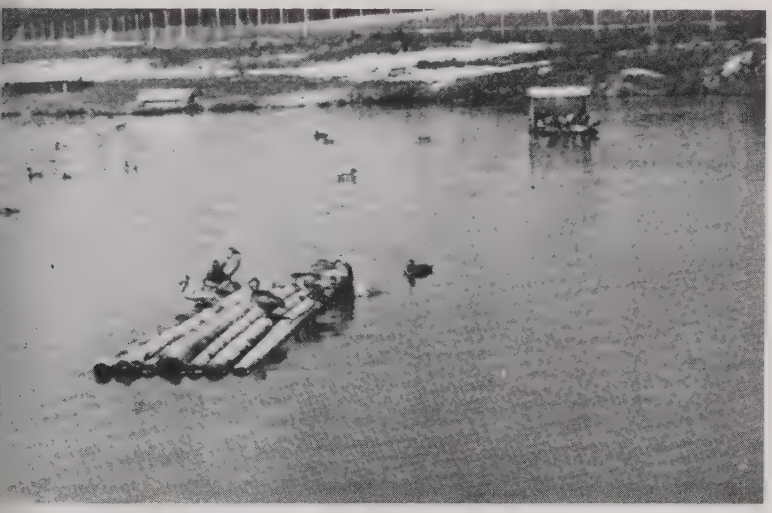
The shores of the rearing ponds were seeded to grass and clo The upland portion of the rearing area was enclosed by a low fenc poultry netting, while a wooden fence enclosed the portion in water. The latter was made of 1- x 6-inch boards spaced an inch a

Figure 13. Rearing pens at Howlands Island.

ıre 14. Construction of board fences used as partitions between duck pens.

gure 14). It was learned by bitter experience that young ducklings ıld dive and swim along the fence. When ¾-inch or 1-inch poultry ting was used many drowned when their heads or bills became ght in the wire.

Shade is extremely important for young ducklings. In 1952 a ıl of 82 ducklings which had been moved recently from the brooder ıse were lost from heat prostration. None among the older age



ıre 15. Log rafts (some with shades) provided loafing spots on the ponds.

classes was affected. Where natural shade in the form of brush or weeds was lacking, artificial shelters were provided.

While the dabbling ducks spent a considerable portion of t time on shore, the divers were more inclined to loaf in rafts on water or on the shoreline at the water's edge. To provide additio loafing facilities, logs or railroad ties were anchored in the pond, these were occupied by dozing ducks almost continuously. Log r also were built and anchored in the pond (Figure 15). On some these, shades were constructed which afforded protection from hot sun.

With facilities such as those described, losses were held at a m mum. It may be noted in the rearing summary (Table 18) for 1 that, of 816 ducklings placed on the rearing ponds, only three w lost up to the fifth week when some were beginning to fly. T represented a mortality of 0.37 per cent for the rearing period.

WINTER MAINTENANCE

The objective of this stage of the study was to determine whe the species on hand could be wintered successfully in open water w out housing or other artificial shelter.

Since no difficulties had been experienced in over-winte either mallards or Canada geese in the latitude of Delmar, all species on hand throughout the investigation were confined in c parable quarters. However, a large building with adequate facil for housing the entire flock was held in readiness in the event of the ducks showed signs of icing during periods of extremely temperature or showed any evidence of loss in weight.

Previous experience had demonstrated a flock of ducks numb ing 100 or more to be capable of maintaining open water in a pon temperatures somewhat below freezing. On the other hand, du prolonged periods of low temperatures, the pond would freeze solidily. Therefore, the first problem was to improvise some de that would effectively and efficiently create a sufficient turbulanc the water to maintain an open area at temperatures as low as – 20 The second problem was to determine whether extremely low t peratures would cause undue stress that would result in loss in we or death from exposure.

A section of one of the ponds which had been used for bree ducks was selected for winter quarters (Figure 16). This was a q shallow pond that froze over readily. Several devices were emplo to maintain an area of open water.

·e 16. Portion of the breeding pen used for wintering ducks at Delmar. Note nest boxes in background.

First, an outboard motor was used. The thrust from the propeller ıted the water so that an area remained ice free even during criti- emperatures. This was soon discarded, however, since, in the small , the motor oil used in the fuel mixture was exhausted and created m on the water. It was feared that enough of this residue might mulate to affect the feathers of the birds. The unit was modified ıe outboard motor could be driven by a belt from an electric motor. ıplications arose here, though, as the shaft bearing continually wore due to the thrust.

The next device tested was assembled from inboard-motor parts. ·opeller shaft, strut, and propeller, as well as the necessary bearings pulleys, were assembled. This unit was driven by a 1½ h.p. elec- motor, and the propeller size and pulley sizes were engineered ·cure its full output without overloading it. This unit provided ·ient thrust to keep the water in motion for distances exceeding ·et and was completely satisfactory.

Finally, an electrically driven, high-volume, low-pressure air pump, ng a capacity of 13 cubic feet per minute, was used to supply the or a grid of plastic pipe that was laid on the bottom of the pond. ·s 1/32 inch in diameter were drilled at intervals in the pipe so the volume of air escaping under water would approximate

the capacity of the pump. A total of 420 feet of plastic pipe was u which covered an area 50 feet in diameter. The water depth va from 1 to 2½ feet where the pipe was laid. In principle, this de forced the warmer water from the bottom of the pond to the surf and at the same time agitated it so that an ice-free area was maintai

Even during the coldest days the ducks occupied themselve the water or loafed on the ice adjacent to the open water.

A bed of alfalfa, clover and timothy hay was spread on the and scratch grains were hand-fed in this. After each snowfall, if snow was heavy it was removed, or if it was light, the hay was rep ished or additional hay was added on top. A balanced maintena feed (Holm and Scott, 1954) was made available to the ducks a times.

Daily records of temperature were maintained through the w ter. A maximum-minimum thermometer was placed in the area height of 5 feet above the ground in order to record the daily variat A remote-control recording thermometer recorded both water t perature and the air temperature 6 inches above the water daily.

On two occasions during the winter, the temperature drop to $-20°$ F. While the area of open water was reduced whenever tremely low temperatures persisted, the ducks maintained nor weight and no mortality due to freezing or icing occurred.

During subsequent winters when the temperatures remained $-20°$ F. or lower for several days, it was necessary to cut the ic order to maintain open water. After this experience, the electric driven boat propeller was used exclusively. Even at temperature $-30°$ F., this device created sufficient turbulence to maintain o water.

The observations demonstrated conclusively that redheads, c vasbacks, pintails, gadwalls, shovellers and teal could be winte successfully at temperatures reaching $-30°$ F. without artificial she providing open water was maintained.

CONCLUSIONS

The over-all objective of the investigation was to determ whether the species under observation would respond to mass p duction techniques. It was definitely established that pintails, gadw redheads and canvasbacks will produce a substantial number of e in captivity. The eggs can be hatched successfully in mechan incubators, and the ducklings can be successfully reared and maintai

igh the winter without artificial shelter. Careful selective breed-should contribute to the development of more prolific strains that retain the necessary wild characteristics essential for a successful cking program.

LITERATURE CITED

, A. C. 1923. Life histories of North American wild fowl order Anseres (Part I). U.S. Nat. Mus. Bull. 126.

———. 1925. Life histories of North American wild fowl order Anseres (Part II). U.S. Nat. Mus. Bull. 130.

COUR, J. T. 1956. Waterfowl of the world (Vol. 2). Country Life Lim-ted, London.

IBAUM, H. A. 1944. The canvasback on a prairie marsh. American Wildlife Institute, Washington, D. C.

, E. R., and M. L. SCOTT. 1954. Studies on the nutrition of wild water-fowl. N. Y. Fish and Game Jour. 1(2):171–187.

H. K. 1915. Propagation of wild water-fowl. Bull. 3, National Association of Audubon Societies, New York, N. Y.

———. 1923. Propagation of wild birds. Doubleday, Page & Co., Garden City, N. Y.

INNEY, F. 1957. Seminar on breeding behavior of ducks. Delta Waterfowl Research Station, Delta, Manitoba. (mimeo.)

E, M. D. 1935. Michigan waterfowl management. Game Div., Mich. Dept. Cons.

T. 1940. Profitable game bird management. Beacon Milling Co., Cayuga, N. Y.

———. 1956. Profitable duck management. Beacon Milling Co., Cayuga, N. Y.

ALLS, C. A., JR. 1947. Studies on the domestic goose and artificial in-cubation of goose eggs. M.S. thesis, Ohio State Univ. Lib.

NOFF, A., G. BUMP and E. R. HOLM. 1938. Artificial incubation of ome upland game birds' eggs. Bull. 2, N. Y. S. Cons. Dept.

EFFECTS OF FIVE HERBICIDES ON FARM POND PLANTS AND FISH[1]

Alfred W. Eipper Project Leader
Department of Conservation, Cornell Universit

ABSTRACT

This paper summarizes data obtained from applications of five diff herbicides in central New York farm ponds over a 3-year period. De Fermate, Phygon-XL, copper sulfate, and sodium arsenite were the chem employed. Available information deals chiefly with effects of these herbi on algae, submersed aquatics, and various sizes and species of fish in 30 ponds which received a total of 70 herbicide applications. Ranges in phy chemical determinations in 16 of these ponds were: pH, 7.6–8.8; total linity, 60–170 p.p.m.; surface water temperature, 63°–83° F.; and bo temperature, 60°–79° F. When applied as surface sprays to produce a p water concentration of 0.5 p.p.m. active ingredient by weight, Delrad, Fer and copper sulfate were all equally effective in controlling unbranched fila tous green algae. With respect to treatment cost and safety of small fish, co sulfate had definite advantages over Delrad or Fermate. Tests of Phygo seven ponds were inconclusive, indicating only that 0.25 p.p.m. concentra of this chemical killed neither fish nor plant growths. Sodium arsenite p.p.m. controlled *Hydrodictyon* and *Cladophora* (branched algae little aff by the other chemicals tested), as well as other algae and various subm rooted aquatics in 10 ponds. Information on the effects of different co trations of Delrad on three types of algae and two age groups of minnows obtained in 10 ponds, together with physical-chemical determinations. inconclusive nature of these data, due primarily to the confounding of a ber of variables, clearly demonstrates the need for careful experimental d in planning field tests of aquatic herbicides, with adequate provisions for trols, replicates, and measurements of results.

Filamentous algae and rooted aquatics are common obstacle proper utilization of farm ponds in New York State. An investiga of fish management techniques for New York farm ponds has bee progress since 1949, and since 1952 aquatic herbicides have required in many of these experimental ponds to maintain their fulness for research purposes. Results of some of these treatm are presented herewith. Because aquatic weed control was subordi to the primary objectives of the investigation, information prese here is deficient in many respects. Despite these limitations, the a

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F Valuable assistance in obtaining data was rendered by Dr. J. L. Forney Professor Herrell DeGraff of Cornell University, and by R. W. Wahl E. P. Snyder, former graduate students. Samples of Fermate were sup by R. J. Benoit of the Connecticut Agricultural Experiment Station, samples of Delrad, Phygon and copper sulfate by manufacturers of products.

data may prove useful in supplementing information gained more intensive studies. Results tabulated here also illustrate the iplicity of variables that can be expected in field tests of aquatic icides, and the need for careful experimental design in order for tests to yield informative results.

PROCEDURE

Information given is based on observations in 30 different farm ds which received a total of 70 herbicide applications. All of the ds involved are located in central New York State. Their surface s ranged from 0.1 to 0.7 acre, with an average of 0.3 acre. Most iem were of conventional farm pond morphometry, with maximum hs between 7 and 9 feet.

The herbicides used were: Delrad 50 S (dehydroabietylamine ate, liquid form) and Delrad 70 (paste form), Fermate (ferric ethyldithiocarbamate), Phygon-XL (2, 3-dichloro-1, 4-naphthoone), copper sulfate, and sodium arsenite. All compounds were ied as surface sprays with a backpack pressure sprayer except for ad 70, which was applied by the "float method" described by rence (1954). Ponds were treated between June 1 and September most of them in July and August) in the years 1953 to 1956, sive. Although in a few instances successive applications of a icular compound were made in a single pond, in all cases there at least a 4-week interval between applications of different comds to a given pond.

In treating a pond, the general procedure was to determine pond me and then to weigh out and apply the amount of chemical necesto produce a predetermined concentration (p.p.m. active ingret) in that volume of water. Prior to treatment, ponds were inted to estimate the extent of algal or other growth. All ponds pt those treated with sodium arsenite had 30 to 100 per cent of surface areas covered with algae at the time of treatment. In ral, branched algae (*Hydrodictyon, Cladophora*) were identified enus, whereas unbranched filamentous forms were simply classed ch, although genera were determined in some instances.

Information on the species, sizes, and relative abundance of fish ach of the ponds was available from inventories made before and treatment. Fish involved in the tests were:

Brook trout	*Salvelinus fontinalis*
Rainbow trout	*Salmo gairdneri*

Brook x brown trout hybrid	*Salvelinus fontinalis* x *Salmo trutta*
Northern pike	*Esox lucius*
White sucker	*Catostomus commersoni*
Carp	*Cyprinus carpio*
Golden shiner	*Notemigonus crysoleucas*
Fathead minnow	*Pimephales promelas*
Brown bullhead	*Ictalurus nebulosus*
Channel catfish	*Ictalurus punctatus*
Largemouth bass	*Micropterus salmoides*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*Lepomis marrochirus*

Data on pH, total alkalinity, and temperature of surface bottom waters were obtained just prior to application of a weedk in 16 of the ponds.

In most cases, ponds were inspected 1 and 5 days after treatm Ponds receiving sodium arsenite were inspected 1 to 2 days and a 10 to 14 days after treatment, because of the slower herbicidal ac of this compound. At each pond inspection estimates were mad the percentages of filamentous algae and other weeds that had killed. These estimates included all visible plant life in the p which usually constituted all material to a depth of 4 or 5 feet.

An equally important objective of the pond inspections wa determine the effect of aquatic herbicides on fish life. Appear of dead or dying fish within 48 hours following treatment was index used to assess toxicity of an herbicide to fish life. Any kills were classified (according to species and size group of fish "heavy" or "moderate". No "light" kills resulting from applica of weedkillers were observed. However, it is entirely possible some light or even moderate kills may have gone undetected, par larly in cases where small fish (3 inches or less in length) were invol

FINDINGS

Following are the data obtained regarding pond character and the effects of the herbicides used.

PHYSICAL-CHEMICAL CHARACTERISTICS OF PONDS

As mentioned earlier, measurements of pH, total alkalinity, temperature preceded 16 of the 70 herbicide applications. Means ranges for the data obtained are given in Table 1. These stat

E 1. Physical-chemical Characteristics of Farm Ponds Prior to Application of Herbicides*

tistic	pH	Total alkalinity in p.p.m.	Water temperature in degrees Fahrenheit	
			Surface	Bottom
1.....	8.4	104	76	74
e.....	7.6—8.8	60—170	63—83	60—79

*Means and ranges for observations from 16 different ponds.

esent 16 of the 30 test ponds under consideration. Furthermore, h additional information on the degree of chemical diversity in ral New York farm ponds has been obtained in other studies ucted during the past three years (Forney, 1957). In the light ese data, it is highly probable that physical-chemical character- of all ponds on all treatment dates closely approximated those esented in Table 1.

ECTS OF HERBICIDES ON AQUATIC PLANTS AND FISH

Observed effects of various concentrations of the five chemical pounds on aquatic plants and on fish are summarized in Tables 2 3, respectively. All concentrations are expressed in parts per on active ingredient by weight.

DELRAD 50 S The minimum concentration necessary to con- algae was 0.5 p.p.m. for unbranched filamentous forms (*Spirogyra, nema*, and others) and *Hydrodictyon*. Concentrations necessary dequately control *Cladophora* were not determined, but 0.5 p.p.m. eared inadequate (at a water temperature of 73° F.) to kill more the surface mats of this alga. Although 1 p.p.m. gave inadequate rol of *Chara* in two ponds, this may have been at least partly due ne fact that bottom water temperatures in these ponds were below F. *Lemna, Marsilea,* and *Typha* were unaffected by Delrad appli- ns of 1 p.p.m. Available data on maximum concentrations of ad safe for various species and sizes of fish are summarized in le 4.

From these data it would appear that the concentration of Delrad ssary to control adequately most of the algae encountered in these (0.5 p.p.m.) was safe for fish over 3 inches long. It is unfortu- that more critical information was not obtained on the toxicity of ad to small fish (under 1½ inches) other than golden shiners and

Table 2. Effects of Five Chemical Compounds on Algae and O
Aquatic Plants in Central New York Farm Ponds

Concentration as p.p.m. of active ingredient	Number of ponds	Effect on aquatic vegetation	
		Kind	Averag percent killed
Delrad 50 S			
0.25	1	filamentous algae§	50
	1	*Hydrodictyon*	40
0.30—0.33	4	filamentous algae§	85
	1	*Hydrodictyon*	60
	2	*Cladophora*	50
0.50—0.60	9	filamentous algae§	90
	1	*Hydrodictyon*	95
	1	*Cladophora*	0
	1	*Potamogeton foliosus*	0
0.75	2	*Chara*	30
1.00	1	*Hydrodictyon*	100
	2	*Chara*	35
	2	*Lemna*, *Marsilea*, and *Typha*	0
Delrad 70 (single float)			
0.50	2	*Cladophora*	15
0.75	1	*Hydrodictyon*	15
Fermate			
0.50	2	filamentous algae§	90
1.50	1	*Cladophora*	60
3.00	1	*Cladophora*	80
Phygon–XL			
0.10	1	filamentous algae§	0
	3	*Chara*	10
0.25	2	filamentous algae§	0
0.50	1	*Chara*	20
Copper sulfate			
0.50	6	filamentous algae§	97
	1	*Hydrodictyon*	50
	1	*Cladophora*	50
	4	rooted aquatics†	0
1.00	2	filamentous algae§	100
	1	*Hydrodictyon*	70
	1	*Cladophora*	60
	1	*Lemna*	0
Sodium arsenite			
4.00	3	filamentous algae§	97
	1	*Hydrodictyon*	100
	2	*Cladophora*	100
	4	rooted aquatics†	100

* Mean of visual estimates of maximum percentages killed in individual po
§ Denotes unbranched filamentous green algae such as *Spirogyra*, *Zygn* and others not identified to genus.
† Various submerged rooted aquatics, principally *Potamogeton* spp., *El canadensis*, and *Myriophyllum* sp.

.E 3. OBSERVED EFFECTS OF FIVE CHEMICAL COMPOUNDS ON FISH LIFE IN CENTRAL NEW YORK FARM PONDS

centration as .m. of active ngredient	Fish present		Number of ponds in which observed kill was:		
	Species	Size range in inches	Heavy	Moderate	None
Delrad 50 S					
.25	Largemouth bass	2 —12	0	0	2
	Bluegill	1 — 6	0	0	2
	Golden shiner	2 — 3	0	0	1
	Golden shiner	½— 1½	1	0	0
.30—0.33	Largemouth bass	2 —12	0	0	6
	Bluegill	1 — 6	0	0	6
	Golden shiner	2 — 3	0	0	2
	Sucker	1½— 4	0	0	2
.50—0.60	Largemouth bass	2 —12	0	0	9
	Bluegill	1 — 6	0	0	8
	Golden shiner	½— 1½	1	1	0
	Golden shiner	2 — 3	0	1	3
	Catfish	9 —12	0	0	1
.75	Trout*	3 — 9	0	0	2
	Catfish	12 —16	0	0	1
.00	Trout*	4 —10	0	0	3
	Golden shiner	½— 1½	2	0	0
	Golden shiner	3 — 4	0	1	1
	Sucker	1½— 3	1	0	1
	Largemouth bass	1 — 2	1	0	0
Delrad 70 (single float)					
.50	Golden shiner	½— 3	0	0	2
	Trout*	10 —14	0	0	1
Fermate					
.50	Miscellaneous§	various	0	0	1
Phygon–XL					
.10	Trout*	2 — 9	0	0	2
	Catfish	9 —16	0	0	2
.25	Largemouth bass	2 —12	0	0	2
	Bluegill	1 — 6	0	0	1
	Golden shiner	½— 4	0	0	1
.50	Trout*	2 — 4	0	0	1
Copper sulfate					
.50	Largemouth bass	2 —12	0	0	3
	Bluegill	1 — 6	0	0	3
	Trout*	6 —15	0	0	4
.00	Largemouth bass	2 —12	0	0	1
	Golden shiner	1 — 4	0	0	1
	Trout*	7 —10	0	0	2
Sodium arsenite					
.00	Largemouth bass	2 —12	0	0	3
	Bluegill	1 — 6	0	0	2
	Golden shiner	1½— 3	0	0	4
	Fathead minnow	½— 2½	0	0	1
	Trout*	4 —12	0	0	4

Denotes brook trout, rainbow trout, or brook x brown trout hybrids.
All warm-water species, including largemouth bass, pumpkinseed, brown bullhead, carp, golden shiner, and northern pike.

Table 4. Maximum Concentrations of Delrad Safe for Various Spec and Sizes of Fish as Indicated by Available Data

Species	Size range in inches	Maximum saf concentration in p.p.m.
Golden shiner	½—1½	less than 0.2
	2—3	0.33
	3—4	less than 1
White sucker	1½—3	0.5
Bass	1—2	less than 1
	2—12	more than 0.
Bluegill	1—6	more than 0.
Catfish	9—16	more than 1
Trout	4—10	more than 1

white suckers. As stated earlier, moderate kills of small fish may h gone undetected in the bass-bluegill ponds treated with Delrad. La rence (*op. cit.*) noted that this compound is toxic to bluegills a young largemouth bass at a concentration of 0.7 p.p.m. in Alaba

Delrad 70 This compound (in paste form) was applied the float method to two ponds. In a 0.33-acre pond containing *Hyd dictyon*, a single application of Delrad was made, using one fl with enough of the paste to produce a total pond concentration 0.75 p.p.m. active ingredient. The other pond, 0.15 acre in surf area and contaminated with *Cladophora*, received sufficient Delrad to give a water concentration of 0.5 p.p.m. on each of two succes days, again using a single float. In both ponds only the algae wit a 20-foot radius of the float were killed, due perhaps to the rest tion of water circulation by the dense algal growths. None of 10- to 14-inch trout or ½- to 3-inch golden shiners present in th ponds appeared to have been killed.

Fermate This compound killed 90 per cent of the unbranch filamentous algae in two ponds to which it was applied at 0.5 p.p. but only 60 and 80 per cent of the *Cladophora* in two ponds trea with 1.5 and 3 p.p.m., respectively. Fish (a miscellaneous assortmen warm-water species) were present in one of the ponds treated with p.p.m., and 23 days after treatment one northern pike, one largemo bass, and two common sunfish became completely blind. These ob

ons, coupled with severe fin erosion in all lots of 3-inch trout used ome preliminary aquarium tests of Fermate, suggest that this com- nd may damage fish tissues.

Phygon-XL In the limited tests conducted with this material centrations of 0.5 p.p.m. did not kill golden shiners (½ to 4 inches g), largemouth bass (2 to 12 inches), bluegills (1 to 6 inches) or nnel catfish (9 to 16 inches). This concentration also failed to unbranched filamentous algae. A single application of 0.5 p.p.m. gon in one pond failed to control *Chara,* but results of this test may e been influenced by low water temperature (66° F. at a depth of 3). Trout 2 to 4 inches long were not adversely affected by this tment.

Copper Sulfate This chemical killed 97 per cent of the un- ched filamentous algae in six ponds at a concentration of 0.5 m., but generally failed to give adequate control of *Hydrodictyon Cladophora* at 1 p.p.m. Higher aquatic plants were not visibly cted by copper sulfate at these concentrations. In the tests de- ed here bluegills and golden shiners 1 inch and more in length, emouth bass 2 to 12 inches long, and trout 7 to 10 inches long e not killed by copper sulfate concentrations of 1 p.p.m. In one d (not included in Tables 1 to 3) having a total alkalinity of only p.p.m., a copper sulfate treatment of slightly over 1 p.p.m. caused artial kill of golden shiners.

Sodium Arsenite At 4 p.p.m., sodium arsenite controlled unbranched filamentous algae *(Hydrodictyon, Cladophora)* and all ed aquatics *(Potamogeton, Elodea, Myriophyllum)* in 10 ponds. s concentration had no observable adverse effects on the five fish ies present in these ponds, including 1½-inch golden shiners, 1-inch egills, and ½-inch fathead minnows.

mbined Data

Relatively detailed physical, chemical, and biological data were ined in 10 ponds treated with Delrad in the summer of 1955. se data are summarized in Table 5. The chief value of this tab- ion is to illustrate the number of variables which may determine results of an aquatic herbicide application. There seems little bt that the general lack of correlation between any of these vari- s was due to the absence of experimental design. Variables in- ed in these tests included:

Physical-chemical
- Pond area
- Water temperatures (surface and bottom)
- Total alkalinity
- pH

Treatment
- Concentration
- Elapsed time between treatment and observation

Vegetation
- Kind
- Stage of development
- Amount present (surface and bottom)
- Amount killed (surface and bottom)

Fish
- Kind
- Size
- Number

There is no need to elaborate on the variety and complexity interactions between these factors which may have confounded results given in Table 5. In view of the number of variables involv it is obvious that these tests were entirely inadequate to meas treatment effects. Despite the fact that within the 10 ponds there considerable replication with respect to any one variable, when or even several of the variables are considered together, the represent simply the results of 10 individual unreplicated tests, no of them comparable.

DISCUSSION AND CONCLUSIONS

In ponds treated with Delrad, Fermate, or copper sulfate, m mum kills of algae occurred within 4 days of treatment. Maxim effectiveness of sodium arsenite was usually attained 7 to 10 after treatment.

Regardless of the compound used to kill them, algae which been 90 to 100 per cent eliminated from a given pond often sta to grow back again after 2 to 3 weeks. This statement is less ap cable in the case of sodium arsenite, treatments with which were o followed by a dense phytoplankton bloom that tended to inhibit gro of filamentous algae.

Although by no means conclusive, some of the data obtained dicate that effectiveness of Delrad and copper sulfate decreased

TABLE 5. PHYSICAL-CHEMICAL DATA AND EFFECTS OF VARIOUS CONCENTRATIONS OF DELRAD ON THREE TYPES OF ALGAE AND TWO AGE GROUPS OF MINNOWS IN 10 FARM PONDS

Pond						Treatment*		Algae†				Fish kill‡	
		Temperature (degrees Fahrenheit)						Present		Percentage killed			
Pond number	Area (acres)	Surface	Bottom	Total alkalinity	pH	Concentration (p.p.m.)	Elapsed time§ (days)	Kind	Per cent	Surface	Bottom	Yearling	Young-of-the year
1	0.23	80	77	170	8.4	0.30	4	*Spirogyra*	20	90	90	0	(n.p.)
2	0.24	83	79	140	8.5	0.30	4	& *Zygnema*	30	70	..	0	(n.p.)
3	0.26	83	79	140	8.5	0.60	4		30	100	100	moderate	(n.p.)
4	0.19	79	78	155	8.8	0.25	4	*Hydrodictyon*	70	80	0	0	heavy
5	0.40	82	78	160	8.8	0.50	4		80	100	95	0	(n.p.)
6	0.40	69	69	70	8.4	1.00	2		80	100	..	(n.p.)	heavy
7	0.15	79	77	135	..	0.30	4	*Cladophora*	50	100	0	(n.p.)	0
8	0.25	74	72	65	8.8	0.30	2		30	100	0	(n.p.)	0
9	0.30	73	..	70	8.5	0.50	3		50	90	0	0	moderate
10	0.15	76	73	60	8.4	0.50	1		50	0	0	0	0
						0.50	3		50	20	20	0	0

* Concentration of Delrad in pond water, as p.p.m. active ingredient by weight. Delrad 50 S applied as surface spray in ponds 1-9, inclusive; in pond 10, two applications of Delrad 70 (single float method) one day apart.

§ Number of days between time of treatment and time observations of effects were made.

† Amounts of algae present before treatment are expressed as approximate percentage of pond surface covered. Percentages of algae killed in surface and bottom waters are visual approximations.

‡ Yearling and/or young-of-the-year golden shiners in all ponds, except Ponds 8 and 9 which contained white suckers; (n.p.) means fish of designated age group not present.

water temperature, and that in concentrations of 0.5 p.p.m. both c pounds were considerably less effective below temperatures of rou 65° F. These indications are in agreement with findings of o workers.

All fish kills recorded in Table 3 were those observed within hours of the time of application of an herbicide. It therefore se highly improbable that any of these kills could have been caused oxygen depletion. Furthermore, fish kills from oxygen deficit are ch acterized by several distinctive symptoms, none of which were a ciated with any of the kills reported here.

Effects of Phygon-XL on pond plants and fish were not adequa tested in this investigation. Under the conditions prevailing in t reported here, Delrad, Fermate, and copper sulfate appeared to equally effective in controlling unbranched filamentous green al when applied as surface sprays to produce pond water concentrati of 0.5 p.p.m. active ingredient by weight. Indications that Ferm may damage fish tissues suggest that this compound would be unsatisfactory algicide in farm ponds where fish are a considerat In view of the usual necessity for repeated treatments to con algae, the lower cost of copper sulfate is a point in favor of this c pound. In addition, data obtained from this study indicate that total alkalinities of 60 p.p.m. and above, copper sulfate is a safer gicide than Delrad in farm ponds containing very small fish.

For controlling various rooted aquatics and the branched al *Hydrodictyon* and *Cladophora* in ponds containing fish, sodium arse at 4 p.p.m. appeared to be the most satisfactory compound of th tested.

Fairly detailed physical, chemical, and biological data ass ated with herbicide applications in 10 ponds (Table 5) clearly il trate the need for much greater care in conducting field tests of aqu herbicides particularly when effects of chemicals on both weeds and are being studied. To yield meaningful information, such tests m be designed with controls and replicates adequate to prevent c founding of the many variables involved. More accurate quantita methods of measuring the effects of aquatic herbicides are also nee particularly with regard to their effects on young-of-the-year fis

LITERATURE CITED

Forney, J. L. 1957. Chemical characteristics of New York farm ponds. N Fish and Game Jour. 4(2):203–212.

Lawrence, J. M. 1954. Control of a branched alga, *Pithophora*, in f fishponds. Prog. Fish-Cult. 16(2):83–86.

UCCESSION OF AQUATIC PLANTS IN SMALL ARTIFICIAL MARSHES IN NEW YORK STATE[1]

Chares W. Dane Graduate Assistant
Department of Conservation, Cornell University

ABSTRACT

A study to measure and evaluate successional changes in vegetation that occurred on small marshes developed under Federal Aid Project 48-D was ducted in 1956 on 22 marshes in the Southern Tier and Genesee-Niagara ons of New York. Findings were compared with those of earlier studies Brumsted. On marshes in Region S.T., woody vegetation was largely flooded In Region G-N, shallower flooding and a greater natural drawdown during summer permitted woody cover to remain alive. At the majority of sites Region S.T., emergent cover did not invade the marshes to provide the ssary cover. In comparison, emergents, particularly *Typha,* extensively ded marshes in Region G-N.

The few emergent food species present were low in abundance in both ons. At a few sites in Region S.T., *Sparganium* was becoming abundant. his region, too, extensive mats of *Lemna minor* were found at some sites were generally lacking at sites in Region G-N. Submergent food plants, ominantly *Potamogeton foliosus,* showed initial establishment in marshes egion S.T., but within five years a sharp downward trend was noted. In on G-N, *Potamogeton foliosus* and *P. pectinatus* were abundant with one iption wherever there was no crowding among emergents.

The two regions possess basic physical and chemical differences which, as d from the succession, favor marshes in the lime belt (Region G-N). Only w factors that influence succession were studied. Low transparency of the r limited the growth and invasion depth of submergents in several marshes ie Southern Tier. Total alkalinity, often used as a measure of productivity ough there are other limiting chemical factors, was significant for the marshes ied in Region S.T.; marshes with less than 30 p.p.m. had little vegetation. age total alkalinity differed between Regions S.T. and G-N, being 46 and .p.m., respectively, on the marshes studied in 1953.

The water level during the growing season was the single most important or recognized. Many marshes in Region S.T. possess slopes which drop harply to 24 inches below normal water level (the limit of regional emer- s). In the shallower marshes in Region G-N during years of low water , there was often overcrowding of emergents.

The data indicate the need for coordinating marsh construction in Region with experimentation on how best to build and manage marshes in this i-soil region.

This paper is a report on studies conducted in the summers of 2 and 1953 by Harlan Brumsted and in the summer of 1956 by author. Their purpose was to measure and evaluate successional nges in vegetation, with respect to quantity and quality of water-

---

contribution of Federal Aid in Fish and Wildlife Restoration Project -61-R.

ie author wishes to acknowledge the field assistance of William Anderson, , a student colleague, and the aid received from Oliver H. Hewitt and rlan B. Brumsted of Cornell University in preparing the manuscript.

fowl food and cover, that have occurred on small marshes develo under Federal Aid Project 48-D in New York. Some information the factors influencing succession on these marshes was also obtai

The two regions in which marshes were studied possess basic ferences in water level fluctuation, soil fertility, watershed slo marsh basin slopes and water chemistry. These factors, which af the succession of marsh vegetation, were evaluated on the basi vegetational differences between the two regions.

METHODS

Two restricted regions were selected for study based on the cation of previous studies, soil types and topography. Genesee Niagara Counties comprised Region G-N representing "areas do nated by medium- to moderately fine-textured [high], medium- low-lime soil without fragipans on glacial till", or "areas domina by medium- to fine-textured soils on glacial lake or marine sedimen according to the soil association map of New York State (Co University Department of Agronomy, 1955). The terrain is relati flat. Broome, Chenango, Schuyler and Tioga Counties compr Region S.T. representing "areas dominated by deep medium- to m erately coarse-textured acid soils with [neutral to] strongly acid fr pans on glacial till". This region has less fertile soil and exhibits hilly topography that is typical of New York's Southern Tier.

Selection of the marshes to be studied intensively was based the amount of information previously collected by Brumsted in 1 and 1953. The 22 marshes, 11 in each region, included six of seven on which he had established permanent transect lines. Con ered to a lesser degree in marsh selection were sites studied by K (1955). Those selected for intensive study are listed in Table 1 gether with the date of the first growing season after flooding.

In measuring succession the following methods were emplo (1) Brumsted's (1954) work on the biotic effects of flooding abstracted to give a general conception of the early stages of succes (2) The period between original flooding and the time when pl invaded a marsh was calculated for those found to be the most ab dant food and cover species or that have otherwise been consid as successionally important. (3) Tabulations of species occurrenc the marshes studied during the three surveys, in 1952 and 1953 Brumsted and in 1956 by the writer, were employed as a measur succession. (4) Where precise quantitative estimates of species ab dance were recorded in the early surveys, observations on change

E 1. MARSHES INCLUDED IN STUDY OF AQUATIC PLANT SUCCESSION

County	Owner	Year of first growing season
	Region S. T.	
me	A. Cline	1950
ango	C. Lay	1951
yler	W. Grove	1952
	W. Hazlett	1950
	C. Cotton	1952
	M. Gowan	1952
	*B. Hurlbert	1952
	R. Lippencott #1	1950
	R. Lippencott #2	1951
	*L. Signs	1951
	G. Zorn	1952
	Region G. N	
see	H. Blood	1951
	E. Chase	1951
	*A. Crocker	1950
	*E. Klossner	1950
	D. Porter	1951
	*G. Weaver	1952
	*I. Wiktorski	1951
ara	W. Gotts	1952
	Hartland Conservation Club	1951
	Lockport Conservation Club	1952
	Three-F Conservation Club	1952

*Marshes where permanent transects were established.

ndance were noted in 1956. (5) The combined percentage of rgent and woody cover also was summarized from the vegetational eys and comparisons were made between years. (6) Seven per- ent transects established by Brumsted in 1952 were retraversed nim in 1953, and six were again retraversed in 1956 by the r. These transects provided an accurate quantitative method of lating yearly abundance of a plant species. With one exception, transect was traversed within 2 weeks of the same date in all three s, generally between August 15 and 23.

FINDINGS AND DISCUSSION

The information obtained by each method is presented separately.

Early Stages of Succession

Information on early stages of plant succession is abstracte quoted from Brumsted (1954) as follows:

The unflooded marsh site often possesses a wet, poorly drained (lowest portion of the basin) in which grow cattail *(Typha)* sweet flag *(Acorus)*. "Surrounding this will be a zone of wet- species [e.g., common rush *(Juncus effusus)*] and fringing this one finds mesophytic communities of weeds and grasses".

"The effect of flooding is to bring about a transposition of t communities, up the slope to the vicinity of the full pond level. extent and species composition of these new communities will dep upon such conditions as basin slopes, bottom soils, water transpare and as Hall *et al.* (1946) indicate, the depth of flooding and the son and extent of water level fluctuation."

These factors have permitted a "rapid development of prefe aquatic vegetation in plains [Region G-N] sites". This is fur pointed out in the 1953 observation that, of 25 plains sites, 12 developed extensive stands of *Typha* which were being used as b cover by waterfowl. "It may be stated that the more gentle slopes c acteristic of plains sites, under conditions of greater recession resulted in generally wider zones of wet-land communities than developed in plateau [Region S.T.] sites where opposite condit prevail." Thus in 1953, 24 of 26 plateau sites possessed negli stands of emergents.

"In almost all plateau sites studied, residual herbaceous and sh vegetation provided the only existing emergent cover for water broods. *Juncus effusus* and *Scirpus cyperinus* are two herbac forms important in this respect; the genera *Spirea* and *Salix* inc the most prevalent woody forms. Of the residual woody species w are serving as cover in the plateau, *Spirea alba, Spirea latifolia* several willows, commonly *Salix fragilis, S. sericea,* and *S. rigida* noted most frequently."

Period Between Flooding of a Marsh and Invasion of V tation

The accumulated data (for 1952, 1953 and 1956) were asse by comparing for each species the lapse in time between the first gr ing season after the marsh was flooded and the first season when species was reported in vegetation surveys. Marshes constructe 1952 furnished the best information, as they permitted study of vasion from the first year of flooding.

It is apparent that there was a rapid invasion of the newly flooded hes by submergents, floating species, and emergents. Emergents ed the most rapid invasion rate. This was due to the fact that gents e.g., rice cut grass *(Leersia oryzoides)* and *Typha* in ons S.T. and G-N, *Juncus effusus* in Region S.T., and water plan- *Alisma plantago-aquatica)* in Region G-N—were in many cases nt before flooding. If these residuals were unable to survive, they at least present to effect the pebble-wave action[2] described by isted.

Bur-reed *(Sparganium americanum),* present generally by the d growing season, was an exception to the general pattern that gents invaded a marsh in the first growing season.

It should be pointed out that such early invasion is only part of ssion, as it gives no indication of quantitative successional changes an give little indication of the value of the marsh for waterfowl.

nges in Species Occurrence Between 1952 and 1956

Data from the marshes in Region S.T., where information was able at eight of the sites for each of the three years, have been narized in Table 2 in terms of the number of marshes at which idual species occurred. Data from the marshes in Region G-N for n information was available have also been summarized.

The most pertinent fact with reference to changes in occurrence it in Region S.T. there were few major increases after 1952, and, e the number of marshes represented increased by three or more, hange took place between 1952 and 1953. This supplements the regarding early invasion of the marshes. Secondly, it is noted between 1953 and 1956 the frequency occurrence of the pondweed *nogeton foliosus*[3] decreased in Region S.T.

The number of marshes at which *Scirpus validus* was present in on G-N increased from two in 1952 to five in 1956.

nges in Species Abundance

n Region S.T. submergents showed a marked downward trend. pondweed *Potamogeton foliosus,* an important waterfowl food, ased on four marshes and increased on only one. At two sites

transposition of wetland and emergent communities from the center basin to the vicinity of a new normal water level, in a manner analagous he pattern of waves created by dropping a pebble into quiet water.

erences to *P. foliosus* include other species of *Potamogeton* within the sub- us *Pusilli* (Fernald, 1950).

Table 2. Number of Marshes, Each Year, at Which Important Spe of Aquatic Plants Occurred

Species*	Region S.T.§			Region G-	
	1952	1953	1956	1952	19
Submergents					
Chara sp.	0	1	0	5	
Ludvigia sp.	5	6	7	3	
Potamogeton epihydrus	0	3‡	2	0	
foliosus	2	8‡	6	5	
pectinatus	1	1	0	4	
Floating plants					
Lemna minor	5	6	8	2	
Emergents					
Alisma plantago-aquatica	2	1	2	6	
Eleocharis spp.	7	7	7	7	
Juncus effusus	4	4	6	1	
Leersia oryzoides	4	5	4	4	
Polygonum spp†	1	4‡	3	4	
Scirpus cyperinus	4	4	5	2	
validus	0	0	0	2	
Sparganium americanum	2	5‡	5	1	
Typha spp.	8	7	8	7	

* Nomenclature followed is that of Fernald (1950), except for the g composed of *Sparganium americanum* and *S. androcladum* which is sidered to be all one species *(S. americanum)* according to Clausen (19

§ Total number of marshes in Region S.T. was eight; in Region G-N, s

† Excludes *Polygonum sagittatum*.

‡ Indicates a major change.

(Hurlbert marsh and Signs marsh) *Potamogeton* suffered a severe out between 1953 and 1956. Also between these dates, musk *(Nitella)* made its first appearance and by 1956 was also dead or d out. Such changes in plant abundance may be correlated with silta (causing turbidity) or with changes in water chemistry.

Of the three sites where it occurred in 1953, the pondw *Potamogeton epihydrus* increased on one, remained constant or creased on another, and decreased on the third. This is the specie *Potamogeton* which has been best able to hold its own in marshe Region S.T. and should be considered in planning any extensive pl ing program.

The total amount of emergent vegetation showed little cha A downward trend of *Typha* seemed probable, but *Sparganium* sho an increase at the two sites where quantitative data were recor Arrowhead *(Sagittaria)* and wild rice *(Zizania)* were planted by owners at three marshes. At two of these (Lippencott #1 and # there was little or no success, but at the Grove marsh reasonable suc

agittaria and excellent success of *Zizania* were noted. Millet *inochloa*), reported in 1953 at two marshes and planted in 1954 our others not included in this study, in all cases met with no ess.

In Region G-N successional change in abundance improved the tational habitat. An exception occurred at the Chase marsh e, in the main pond, waterweed (*Anacharis*) increased from a l patch in 1953 to a dense cover on the pond bottom in 1956. pondweed *Potamogeton pectinatus* had previously been the domi- species.

Another muskgrass (*Chara*) decreased at three and increased at marshes for which quantitative information is available. However, atter exhibited an abundance of *Potamogeton*. Despite the favor- increase in occurance of *Scirpus validus*, as noted under a previ- opic, the species did not show a comparable increase in abundance; creased at one site, showed no change at another, and decreased ie third. *Typha* increased at the two sites where quantitative mation was recorded.

Following is a list of species useful as indicators of site character.

Species found only on study sites in Region S.T.

*	*Polygonum amphibium*	common water smartweed
	Potamogeton epihydrus	Nuttall's pondweed
*	*Zizania aquatica*	wild rice

Species found predominantly on study sites in Region S.T.

§	*Potamogeton berchtoldi*	Berchtold's pondweed
	Sparganium americanum	Nuttall's bur-reed

Species found only on study sites in Region G-N

	Eleocharis palustrus	creeping spike rush
	Lemna trisulca	duckweed
*	*Najas sp.*	bushy pondweed
*	*Potamogeton crispus*	curly-leaved pondweed
*	*Riccia fluitans*	liverwort
*	*Riccia natans*	liverwort
	Scirpus validus	soft-stemmed bulrush

Species found predominantly on study sites in Region G-N

Alisma plantago-aquatica	water plantain
Potamogeton pectinatus	sago pondweed

* Single occurrence or two minor occurrences.
§ Reported by Brumsted (1954).

Percentage Changes in Cover

The percentage of cover at each marsh was judged by rough vi estimate and recorded each year. Summarized here are figures for effective cover, which was considered to include emergents, shr and groups of living trees. They are given in Table 3 which inclu those marshes on which information is available for 1952 and 1

Table 3. Total Percentage of Effective Cover on Each Marsh

Region S.T.			Region G–N		
Marsh	1952	1956	Marsh	1952	1
Cline	25	20	Blood	55	
Cotton	25	10	Chase	1	
Gowan	15	70*	Crocker	87	
Grove	30	82*	Gotts	42	
Hazlett	5	5	Hartland Conservation Club	32	
Hurlbert	10	7	Porter	15	
Lay	75	60	Three-F Conservation Club	10	
Signs	10	5	Wiktorski	15	
Zorn	55	45			
Average	28	34		32	

* Marsh where effective cover increased.

Most marshes in Region S.T. exhibited a decrease in total ve tational coverage and some decline in density of the remaining ve tation. This reduction was largely due to a decrease of residual t and shrubs which had been killed by flooding or eaten out by muskr The increase in average vegetational coverage for the region as sh in Table 3 resulted from gains of more than 50 per cent in emerg cover on two marshes—Gowan and Grove. On other marshes a nar band of emergents was typical, due to basin topography, mus activity, and water and soil chemistry. This sparsity of emergent co coupled with the decrease of residual woody plants indicated co deficiency to be an important factor in this region, as evidenced by fact that only 4 out of the 11 marshes possessed adequate cover in 1

In comparison, eight marshes in Region G-N had adequate, so times too much, cover in 1956. The one site that showed a decr was the Crocker marsh, which had slightly less wooded cover as a sult of a spraying experiment, cutting, and some dying out due natural flooding. On 4 of the 11 marshes in this region, there resulted by 1956 a need for reduction of excess dense cover which associated with a lack of edges and of adequate open water for growth of *Potamogeton*.

ends in Plant Abundance as Indicated by Transects

Transects were established at two marshes in Region S.T. and at in Region G-N. A sample portion of a transect line at each marsh selected for detailed evaluation. The length of the sampled on was adjusted where necessary to allow true comparison of frequency changes within similar zones. During the three years, ective lines varied in length, and the vegetation frequency was essed as the percentage of cover per total length of the line sample frequency of stems per 10 linear feet. For the marshes with ect line plots, the same plots were used each year.

Species were often interspersed along a transect line. Thus a on of line might consist of an interspersion of *Lemna minor*, *isulca* and *Chara*. For this section, each species present would ssigned a percentage value based on 100. Thus the three species l have a combined value of 300 per cent for that section. This ains why some of the graphs have total values of over 100 per though open water may have been present. In this work, open r was used to mean that no submergents, no floating plants and mergents were present along the portion of the line referred to. Where the abundance of a single species increased after the first it could have been due to invasion by the species into an open r area, or its replacement of another species, or to its attain- qual interspersion with another species so that both were given ame percentage as was originally given the first. The latter was significant, unless mentioned, and, of course, did not apply to lots.

Figure 1 represents two sample portions (one comprising sub- rent, the other, emergent vegetation) of one line. This transect on the Signs marsh in Region S.T. which had the most constant r water level and dates of study. The successional picture is fore not blurred by water level differences.

In the submergent zone an unmistakable decrease in *Potamogeton sus* occurred between 1952 and 1956, while emergent vegetation me more firmly established in the shallower water in the years 1952.

Data for the east-west transect of the Hurlbert marsh (Figure 2) a relatively constant abundance of total emergents during the years of study despite the water level changes between 1953 1956. The water level did not reach such a depth that *Juncus us*, a residual, was flooded out. This marsh also is in Region S.T.

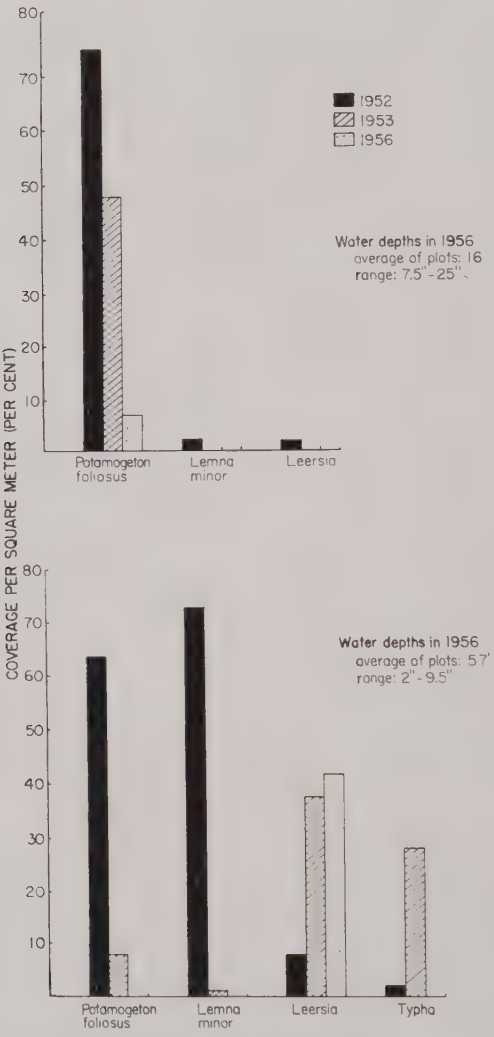
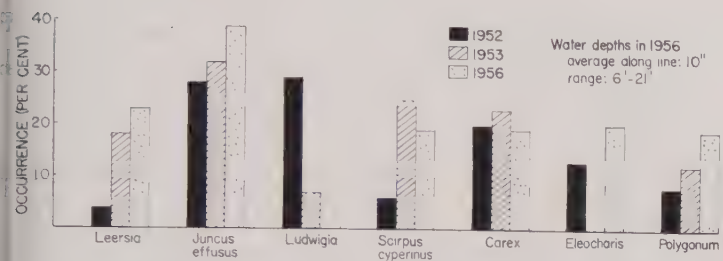
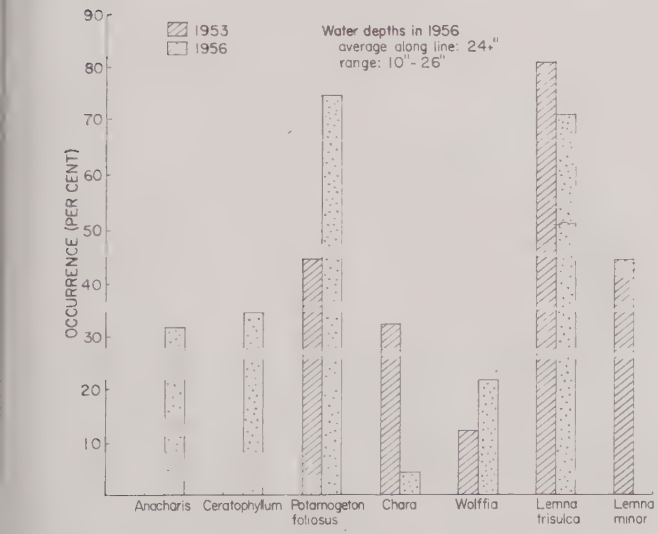


Figure 1. Changes from 1952 to 1956 in the abundance of certain a plants in two portions of north-south transect line at the marsh: submergent zone (upper); emergent zone (lower). was flooded in 1951. Water levels (in relation to normal level) recorded as follows: August 18, 1952—1 inch below; A 16, 1953—4 inches below; August 14, 1956—½ inch abov

The Crocker marsh (Figure 3) was the only one, of the fo Region G-N on which transects were established, that was simi



re 2. Changes from 1952 to 1956 in the abundance of certain aquatic plants in a sample of the east-west transect line at the Hurlbert marsh. Marsh was flooded in 1952. Water levels (in relation to normal water level) recorded as follows: September 19, 1952—4¼ inches below; September 12, 1953—16 inches below; August 16, 1956—2 inches below.



re 3. Changes from 1953 to 1956 in the abundance of certain aquatic plants in a sample of the east-west transect line at the Crocker marsh. Marsh was flooded in 1950. Water levels (in relation to normal water level) recorded as follows: August 31, 1953—6½ inches below; August 22, 1956—1 inch below.

Signs marsh in having a deep central area in addition to the ow pit. The transect traverses this deep-water area and thus rded a comparison with the data obtained for the submergent ion of the transect at the Signs unit as depicted in Figure 1. In r to facilitate the comparison, the *Typha* zone was excluded. The

watershed at this site has a shallower slope. Chemical differences water quality were also noted.

Submergent vegetation increased two-fold at the Crocker ma while it disappeared entirely at the other along the open water p tion of the transect, although in 1953 *Potamogeton foliosus* was m abundant at the latter. Succession at the Crocker marsh seems have been representative of that in marshes in Region G-N in gene *Chara* decreased, but this was balanced by a proportionate incre of *Anacharis*. The fact that *Anacharis* invaded the marsh to a la extent, and may in the future increase more rapidly than *Potamoge* might produce a result similar to that which occurred at the Ch unit where *Anacharis* covered the marsh.

Figure 4 represents the sample along the transect at the Wikto marsh. For all species except *Chara* data were taken along 300 fee the transect line. There was much equal interspersion (predomina among floating and submerged species) as evidenced by the fact t the combined frequency values totaled 214 per cent in 1956. Q apparent was the increase of emergents, stands of which in 1956 w broken by clear areas, thus providing excellent edge effect; contin increase at the rate exhibited during this study might close off clear areas. The percentage of *Chara* was derived from a sample extended for an additional 100 feet and shows a distinct incre between 1953 and 1956 at the expense of the potamogetons on extended section.

The inverse relationships between the amount of algae and th of *Lemna* and of *Potamogeton foliosus* can be seen in the jig-saw fi the corresponding bars on the graph. In the years (1952 and 19 when algal coverage was high, both *Lemna* and *P. foliosus* were prevalent or non-existent. In 1953 the reverse was true.

In 1956, the first year in which *Alisma* and *Typha* were found the transect, densities of less than 0.1 and of about 0.9 stem per linear feet were recorded, respectively.

Figure 5 represents the transect at the Klossner marsh. Fig 6 represents one transect at the Weaver marsh. Both transects emergent cover solely, although that at the latter site was a m open type and thus more preferred by ducks than the comple closed stand of *Typha* at the other. The chief physical differe involved water levels, i.e., the extreme drawdown at the Klos marsh in 1952 and the greater average and range of water depth the other. At both sites the trends of abundance for *Typha* and *Ali*

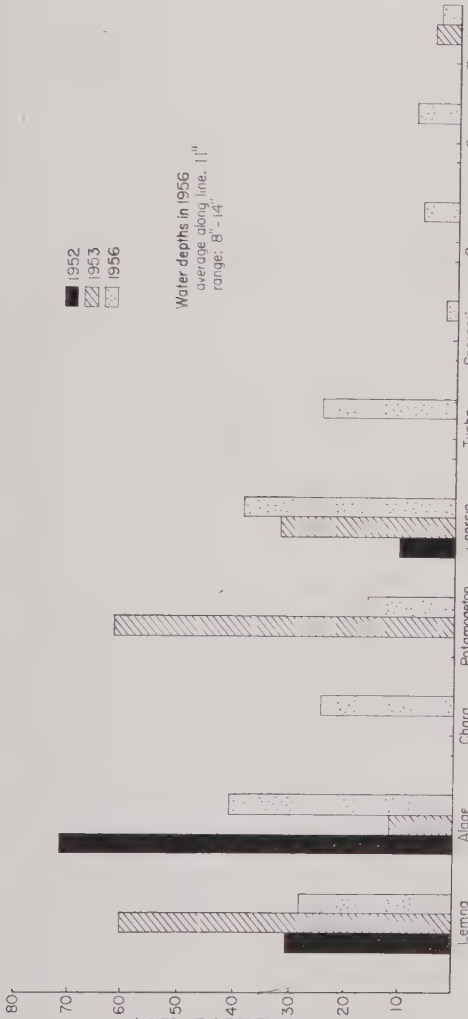


Figure 4. Changes from 1952 to 1956 in the abundance of certain aquatic plants in a sample of the transect line at the Wiktorski marsh. Marsh was flooded in 1951. Water levels (in relation to normal water level) recorded as follows: August 5, 1952—below (amount ?); August 26, 1953—6 inches below; August 20, 1956—8½ inches below.

e inverse. This was also true for each species between the two areas. increase of *Typha* at the Klossner marsh is believed to have been result of: (1) an exposed marsh bottom in 1952 stimulating germi- on of seeds; (2) lower water levels enabling it to recover more kly after being cut by muskrats; (3) the early increase after flood-

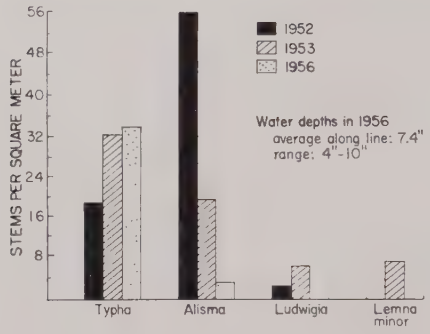


Figure 5. Changes from 1952 to 1956 in the abundance of certain aqu plants in a sample of the transect line at the Klossner marsh. M was flooded in 1950. Water levels (in relation to normal w level) recorded as follows: September 1, 1952—29¾ inches be August 28, 1953—8⅛ inches below; August 22, 1956—8¾ in below.

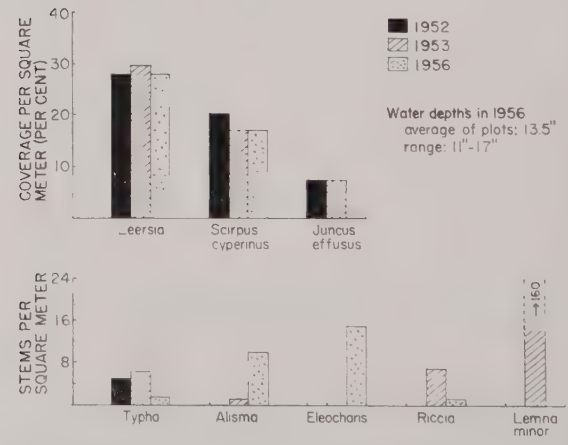


Figure 6. Changes from 1952 to 1956 in the abundance of certain aqu plants in a sample of north-south transect line at the Weaver ma Marsh was flooded in 1952. Water levels (in relation to no water level) recorded as follows: August 28, 1952—10¼ in below; August 15, 1953—8¾ inches below; August 21, 1956- inch below.

ing which enabled the species to withstand heavy cutting by musk that were abundant. The decrease of *Scirpus cyperinus* (heavily cu 1956 but still recorded) and of *Juncus effusus* was probably relate flooding in addition to muskrat cutting. The frequency of *Le minor* was high in 1953 along both transects.

The quantitative analysis afforded by the transects shows that:

1. *Potamogeton foliosus* decreased greatly in Region S.T. and increased in Region G-N.
2. In Region G-N there was a sharp increase of emergents at each marsh between 1952 and 1953 and a continued increase or a constancy between 1953 and 1956.
3. In Region G-N, *Chara* increased at one site and decreased at another.
4. In Region G-N when the muskrat population was high, as at the Klossner and Weaver marshes, the abundance of *Typha* and *Alisma plantago-aquatica* appeared related to water depth and the original amount of the species present, rather than to time as the successional change factor. Of course muskrat populations have a tremendous effect on emergents, particularly *Typha* and *Sparganium*.

tors Influencing Plant Succession in Marshes

In discussing the effects on vegetation of the initial flooding of ted small marshes, Brumsted (1954) pointed out that "the extent species composition of these new communities will depend upon conditions as basin slopes, bottom soils, water transparency, and Hall *et al.* (1946) indicated, the depth of flooding and the season extent of water level fluctuation". With reference to basin slopes water transparency he noted that "the restricted width of the utic emergent zone common to most plateau sites [Region S.T.] is idered by this investigator [Brumsted] to be primarily the combined ts of steeper slopes and colored water which reduce the width e zone of light penetration".

The topography and depth of a marsh basin should be considered Marsh basins in Region S.T. have steep slopes that usually drop apidly to depths of 2 feet or more, in contrast to marshes in Region which possess gradually sloping basins. A summary computed the design plans by Brumsted shows that, for 8 of the 11 Region marshes, 47.2 per cent of the total area had water depths of less 1 foot and 92 per cent had depths of less than 2 feet. In part of on S.T. (Chenango and Tioga Counties) the average for 19 shes was 23 per cent of the water area less than 1 foot in depth only 52 per cent less than 2 feet in depth.

According to Hall *et al.* (1946) "The survival of both woody

and herbaceous species under inundated conditions varies with
species, the season, the water depth, the duration of the hydroper
and the size of the specimens". In order to retain woody resi
cover it would be desirable to know the depth to which a marsh c
be flooded and still retain living trees and shrubs. Due to the
that water levels were not noted in 1954 and 1955 and were
recorded throughout the season at all sites in 1952, 1953 and 1
only a ranking in order of resistance to flooding could be ascerta
from available information when two or more species showed a ma
difference in vigor at a single marsh. Approximate water level
erances were derived by noting the water depth at which individ
of a species were dying in 1956 and correcting this depth to no
water level. Hall *et al.* (1946) stated that "our water tolerant w
species vary not only in tolerance with respect to the duration of
hydroperiod but also with the water depth". Further they pointed
that the species most tolerant to long hydroperiods "are the
tolerant to deep flooding during the growing season".

In Table 4, woody plant species are classified according to
ance of water depth. Rankings by Hall *et al.* (1946) for the s
genera or species (abstracted from a longer list) according to le
of tolerance of a constant flooding level are added for comparis

The water depths to which emergents and submergents had
vaded were studied in order to estimate, before construction, the m
mum percentage of a marsh which might be covered by emergents
5 years of flooding, to estimate the depth to which a secondary cha
should be dug in order to keep emergents from filling the ditch, an
determine whether submergents would be abundant at the dept
this channel. Maximum depths at which these species as a g
existed in 1952, 1953 and 1956 were corrected to normal water l
In 1956, water levels in July and August were higher than u
particularly in Region G-N. Perhaps for some emergents this incre
water level had not as yet effected the death of all individua
water depths beyond the species tolerance. This might mean that
maximum depths suggested are a little too high, but, if this is
case, the difference is certainly not much.

The more abundant emergent species (*Typha*, *Sparganium*, *Alisma*, *Leersia*, and *Juncus effusus*) invaded to maximum depth
26, 25, 24, 18, and 15 inches, respectively. The potamogetons, par
larly in Region G-N, invaded to depths of 24 inches and more. *C*
occurred in depths greater than 24 inches, although at a majorit

LE 4. TOLERANCE OF WATER DEPTH FOR CERTAIN WOODY PLANT SPECIES

Species	Approximate water depth recorded during survey	Tolerance according to Hall
Region G–N		
valanthus occidentalis	20 inches	..
c spp.	12—18	tolerant
inus lanceolata	..	tolerant
pennsylvanica	12—18	..
saccharinum	under 18	tolerant
us americana	10 —12	moderately tolerant
inium corymbosum	2—5	..
inus caroliniana	moist land	intolerant
s grandifolia	moist land	intolerant
a ovata	moist land	intolerant
Region S.T.		
aea spp.	15—30 inches	..
verticillata	20	..
s sp.	under 10	..

it occurred at lesser depths. However, *Scirpus validus* was found rally below 14 inches, with 24 inches as maximum. According Brumsted (1954), "*Juncus effusus* and *Scirpus cyperinus* seem porarily to be tolerating depths of 6 to 10 inches in plateau con- ns".

Bellrose (1941) stated that "marsh plants usually thrive on st soil or in water not more than 18 inches deep. Aquatic plants best in water 18 inches to 4 feet in depth". Hall *et al.* (1946) noted that *Typha latifolia* "sprouts and grows to the water sur- in water 2 feet deep".

Hotchkiss and Moyle (1945) observed "The abundance of vege- n in any lake is dependent upon the chemical quality of the water, the type and fertility of the bottom soil". The methods used Brumsted for determining pH, total alkalinity, water transparency in and turbidity) were Hellige comparator, Taras' total alkalinity cator II, secchi disc, and observation of water in a pint jar, respec- ly. In studying these factors only cursory observations can be le from the data, collected largely by Brumsted in 1952 and 1953.

Among the factors controlling water transparency are turbidity stain. The relation of stain (believed to have been due to decay- woody vegetation) to the abundance of *Potamogeton foliosus* in

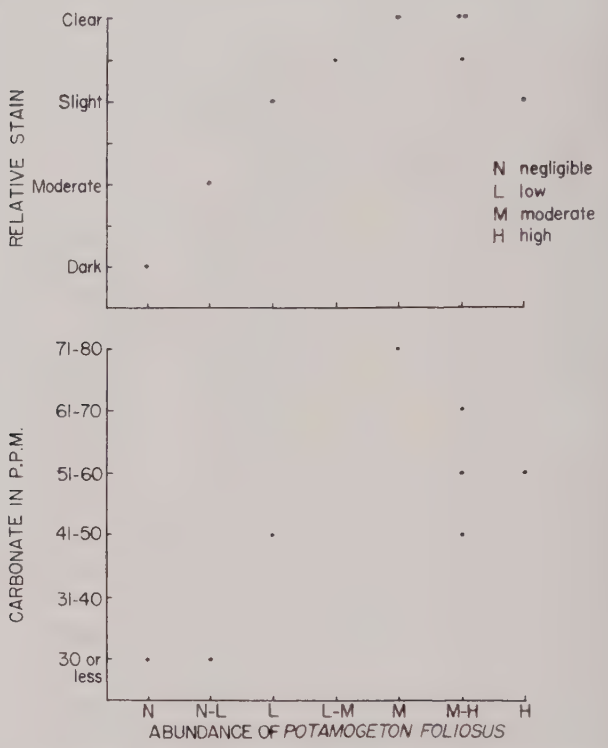


Figure 7. Relation of water coloration and total alkalinity to the abunda of *Potamogeton foliosus* in Region S.T.

marshes in Region S.T. is illustrated in Figure 7. Stain was not inte enough to be considered a factor in Region G-N.

In 1953 the average water acidity for marshes in Region S was pH 7.4 and total alkalinity was 46.5 p.p.m. of carbonate. contrast to this the corresponding values for Region G-N were 7.16 and 84.0 p.p.m. of carbonate. Moyle (1956) noted that to alkalinity is often used as a measure of productivity although th are other limiting chemical factors (e.g., sulfate ion concentrat and nitrogen) and that, "waters may be fairly high in carbonates low in some other critical element". Total alkalinity is more c stant than pH and has been related to *Potamogeton foliosus* abunda (Figure 7). These data indicate that, for Region S.T. in 1953, th waters with a total alkalinity of less than 30 p.p.m. (26 and 28 p.p.r possessed low amounts of *Potamogeton*. A similar relationship also reported by Hotchkiss and Moyle (1945) who noted that wa with less than 40 p.p.m. of total alkalinity and a pH between 6.8 a

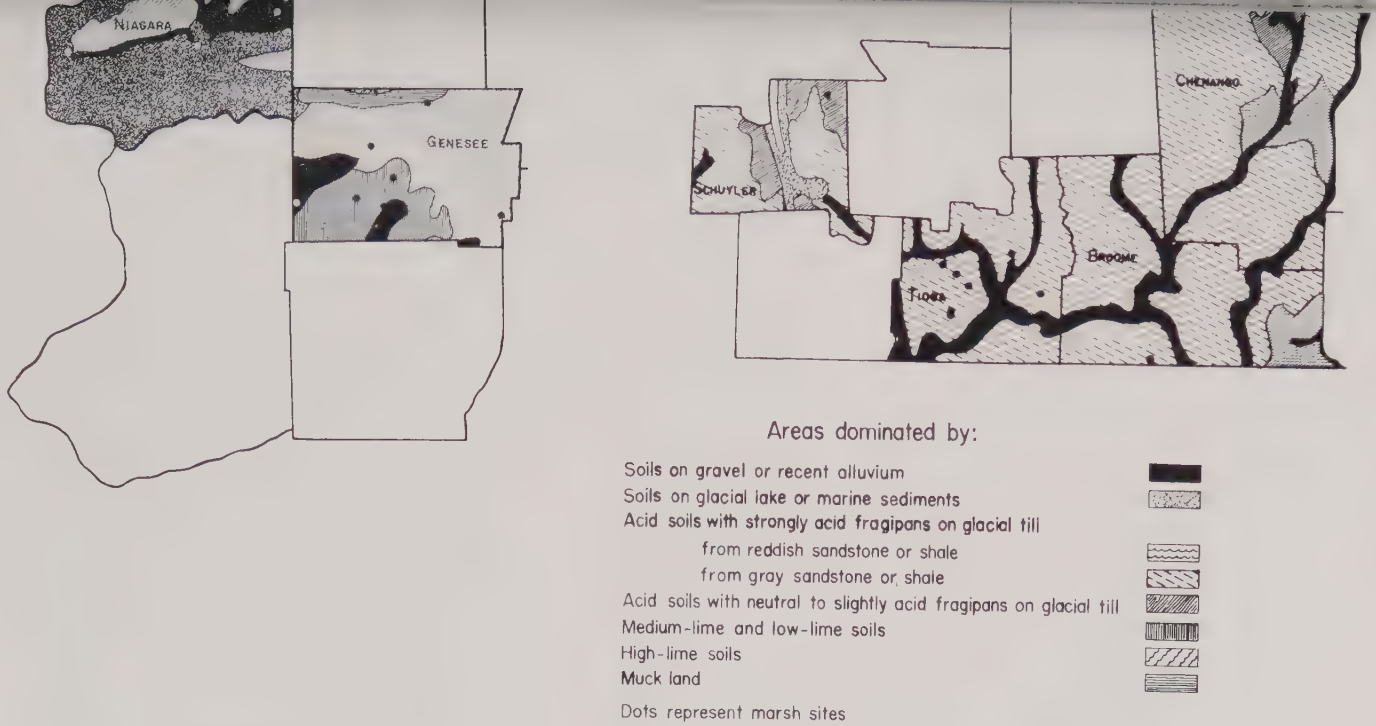


Figure 8. Distribution of the marshes studied in relation to the soil associations in the regions.

7.4 had sparse aquatic vegetation. Differences in average pH alkalinity are in general related to the soil types involved. Distribu of the marshes under study in relation to the soil associations of two regions is illustrated in Figure 8.

In general, abundance of emergent cover, abundance of mergent food, retainment of residual woody cover, slope of the m basin, and favorable marsh-basin depths are more favorable in Re G-N than in Region S.T. Also, as brought out by Brumsted (19 "prospects of continued trends in draining wet-land in this re [Region G-N] suggest that it may be expedient to make the fu use of development opportunities in the region". Brumsted's st ment can even be extended to suggest the possibility of buyins permanently leasing sites in this area. Also there is need for r study of marshes in areas (e.g., Region S.T.) with soil associations are acid in order to evolve satisfactory management practices. C tinued construction of marshes in such acid soil should proceed caution because many might have to be drained and reconstru when proper management practices are established. Such rese on the poorer sites will show results when conservation interests not compete for available sites on good agricultural land, such Region G-N, and waterfowl habitat must be sought where land is at a premium.

LITERATURE CITED

Bellrose, F. C., Jr. 1941. Duck food plants of the Illinois River va Illinois Nat. Hist. Sur. Bull. 21(8):237-280.

Brumsted, Harlan B. 1954. Some causes and effects of water level fluctua in artificial marshes in New York State. Phd.D. thesis, Cornell Univ.

Clausen, R. T. 1949. Checklist of the vascular plants of the Cayuga q rangle. Cornell Univ. Agr. Exp. Sta. Memoir 291.

Fernald, M. L. 1950. Gray's Manual of Botany. 8th ed. Amer. Book New York.

Hall, T. F., W. T. Penfound and A. D. Hess. 1946. Water level rela ships of plants in the Tennessee Valley with particular reference to ma control. Jour. Tenn. Acad. Sci. 21:18-59.

Hotchkiss, Neil and J. B. Moyle. 1945. The aquatic and marsh veget of Minnesota and its value to waterfowl. Minn. Dept. of Cons., T Bull. 3.

Klein, Harold G. 1955. Wood duck production and use of nest boxe some small marshes in New York. New York Fish and Game Jour. 2 68-83.

Moyle, John B. 1956. Relationships between the chemistry of Minn surface waters and wildlife management. Jour. Wildl. Mgt. 20(3):303

Cornell University Department of Agronomy. 1955. Soil associ map of New York State (compiled by M. G. Cline). Cornell Unive Ithaca, New York.

FOODS OF MINK IN NEW YORK[1]

. J. Hamilton, Jr. Professor of Zoology
Department of Conservation, Cornell University

ABSTRACT

Fall and winter stomach and intestinal analysis of 630 trapped mink from videly separated sources in New York State reveal the following percentage ency indices: fish, 34.1; mammals, 33.2; amphibians, 21.9; crustacea, 14.4; s, 6.8; birds, 2.7; earthworms, 2.4; molluscs, 1.6; reptiles, 1.4; and vege-, 0.3. Muskrats had been eaten by 5.4 per cent of the mink.

Summer foods, represented by 561 scats, have the following percentage ency indices: mammals, 44.0; fish, 32.4; insects, 29.2; amphibians, 18.9; sh, 12.7; birds, 9.3; reptiles, 4.1; and snails, 0.7.

The combined analyses of 1,191 summer, fall and winter samples provide ollowing percentage frequencies: mammals, 38.3; fish, 33.3; amphibians, insects, 17.4; crayfish, 13.4; birds, 5.8; reptiles, 2.7; earthworms, 1.3; scs, 1.2; and vegetation, 0.2.

Since the mink is an important furbearer, carcasses can be secured me numbers from trappers during the open season. Spring and ner food analysis is dependent upon the examination of scats. wo food studies made in southwestern Pennsylvania 204 mink n in late fall were examined (Guilday, 1949; Grimm and Roberts,). The combined figures, indicating percentage frequency of rrence, are: mammals, 42.6; insects and spiders, 22.5; fish, 20.6; ish, 16.7; birds, 3.4; amphibians, 2.4; and carrion, 1.5. Mice, ipally *Microtus,* occurred in 30 per cent of the stomachs. Dear- (1932) reported on the winter food of 297 Michigan mink. His ntage frequency indices for the various foods are: mammals, 3; fish, 18.35; frogs, 8.55; crayfish, 7.91; birds, 5.70; insects, 2.27; snakes, 1.59. Muskrats represented 65.92 per cent of the mammals; ntails, 14.77 per cent; and field mice, 14.21 per cent. Seventy- summer scats examined by Dearborn provided the following metric percentage indices: crayfish, 68.22; mammals, 19.64; frogs, ; fish, 2.87; insects, 2.02; birds, 0.89; and snakes, 0.61. Sealander 3) examined 201 winter-trapped mink. The percentage fre- cies reported for those containing food are: mammals, 70;

---

providing mink carcasses, the author is indepted to August M. Becker, l J. Benoit, Wellington Benson, Richard F. Emperor, William A. Flick, M. Johnson, Willard Racha, Lloyd Signs, Ives Turner, Edward R. Maun-, Allen Washburn, and the Western New York Trappers Asociation through bert Holmquist.

amphibians, 23; birds, 13; fish, 11; arthropods, 6; and reptiles
Hamilton (1936) examined 70 fall- and winter-trapped New Y
mink and reported the following foods in percentage frequency
occurrence: mammals (chiefly *Microtus*), 32.94; fish, 18.82; cray
16.47; muskrat, 14.12; insects, 7.06; rabbits, 4.71; frogs, 2.36; m
2.36; and grasses, 1.18. Darrow (1947) reported on eight n
stomachs for New York. Three contained muskrat remains, one
a mouse and a crayfish, and the remainder miscellaneous items.

FALL AND WINTER FOODS

Mink carcasses were collected from 1926 to 1957, 91 per
being trapped from 1948 to 1957. Of the 774 animals exami
630 (81.4 per cent) contained food in either the stomach or alimen
tract. Often undigested food is restricted to the hind gut. Trap del
as well as claws and fur of mink, represent items ingested during
animal's struggle to free itself and are not considered in the tabulati
Baits are seldom used by New York trappers. Either a scent is
ployed to attract the animals, or blind sets are made on their tr
lines.

Of the total containing food, 201 specimens were taken in
Adirondacks, principally in western Essex, Franklin, northern Herki
and Hamilton, and St. Lawrence Counties; 126 in Genesee and
Counties; 145 in Chautauqua County, principally about the Jamest
region; 140 in the central western counties of Chemung, Schu
Steuben, Tioga and Tompkins; and 18 in Suffolk County. Mink
taken on streams, marshes and tidal flats. Populations in areas
side the Adirondacks produced larger animals than those within
region. Male mink wander more widely than do the females;
sequently this is reflected in the number that were trapped. Of
630 animals, 364 (57.8 per cent) were males and 266 (42.2 per c
females.

Contents of the stomach and intestine were placed in a fine-m
food strainer held over an enamel pan, and a stream of water
directed on the food. Material small enough to pass through the m
and into the pan was then strained onto cheesecloth. This procedu
desirable to retain small endoparasites (cestodes and acanthocephala
After separation of the food from adventitious material, it was
amined under a binocular microscope. Results of the analysis
presented in Table 1.

Following is a brief discussion of the types of food represen

I

As one might expect from their abundance, members of the rinidae were taken more frequently than all other families com- d. Undoubtedly a large proportion of the undetermined fish were esented by various species of minnows. Pharyngeal teeth are fre- ntly recovered from mink stomachs, and are an aid in identifying e species. Among the cypinids, horned dace *(Semotilus atromacu- s)* and common shiners *(Notropis cornutus)* were determined n 19 mink. The blacknose dace *(Rhinichthys atratulus)* and golden er *(Notemigonus crysoleucas)* each occurred in two mink. Most ne trout remains were found in mink from the Adirondack region n in early November. A few stomachs contained the remains of t and their eggs. Both brook trout and brown trout were repre- ed. These fish spawn in late October and early November, selecting low water over gravel, where they are presumably vulnerable to lation. The mink from Long Island marshes had fed principally n the abundant mummichog *(Fundulus heteroclitus)*. The cen- chids included the common pumpkinseed *(Lepomis gibbosus)* and smallmouth bass *(Micropterus dolomieui)*.

Suckers, as judged by the pharyngeals, were all small individuals *Catostomus*, probably not exceeding 7 inches in length. Percids nded six instances of *Perca* and a darter *(Etheostoma nigrum)*. nains of a few bullheads, small pickerel and a single mudminnow e up the remaining identified fish.

MMALS

Occurring in essentially a third of the mink, mammals were eaten ost as frequently as fish. The widespread field mouse *(Microtus nsylvanicus)* is usually common to abundant in mink habitat and is ely utilized for food. Muskrats occurred in 5.4 per cent of the k containing identifiable food remains. This is a notably lower dence than that indicated in Dearborn's studies where mammals stituted 55.63 per cent of the food items taken by 297 mink, and krats comprised 65.92 per cent of all mammal items recorded. In analysis of mink predation on the muskrat, Errington (1943) set n in great detail the seasonal and special aspects which determine predation, e.g., muskrats are particularly vulnerable to the mink ng low-water winters; young muskrats affected by drought crises overpopulated habitats also are materially reduced by mink pre- on. In the Adirondack and Long Island mink habitats represented

Table 1. Fall and Winter Foods of 630 New York Mink

Food	Number of occurrences		Percentag frequenc
Fish	215		34.1
Cyprinidae (minnows, shiners, etc.)		88	14
Salmonidae (trout)		16	2
Centrarchidae (bass, sunfish, etc.)		11	1
Cyprinodontidae (killifish)		8	1
Percidae (perch)		7	1
Catostomidae (suckers)		7	1
Ameiuridae (bullheads)		4	0
Esocidae (pickerel)		4	0
Umbridae (mudminnows)		1	0
Undetermined		72	11
Mammals	209		33.2
Microtus (field mouse)		78	12
Ondatra (muskrat)		34	5
Blarina (short-tailed shrew)		30	4
Sylvilagus (cottontail rabbit)		18	2
Peromyscus (deer mouse)		11	1
Condylura (star-nosed mole)		7	1
Rattus (rat)		4	0
Sorex (shrew)		3	0
Clethrionomys (red-backed mouse)		2	0
Glaucomys (flying squirrel)		1	0
Sciurus (gray squirrel)		1	0
Tamiasciurus (red squirrel)		1	0
Mustela erminea (small brown weasel)		1	0
Undetermined		26	4
Amphibians	138		21.9
Ranidae (frogs)		119	18
Plethodontidae (salamanders)		15	2
Ambystomidae (salamanders)		5	0
Crustaceans	91		14.4
Cambarus (crayfish)		89	14
Uca (fiddler crab)		2	0
Insects	43		6.8
Coleoptera: Dytiscidae (water beetles)		10	1
Diptera: Tipulidae (crane flies)		9	1
Neuroptera (dobson-fly, etc.)		8	1
Plecoptera (stone-flies)		7	1
Trichoptera (caddis-flies)		5	0
Orthoptera (grasshoppers, etc.)		2	0
Hemiptera: *Abedus* (water bug)		1	0
Undetermined		3	0
Birds	17		2.7
Finches (Fringillidae)		7	1
Pheasant		4	0
Duck		1	0
Red-winged blackbird		1	0
Chicken		1	0
Undetermined		3	0
Earthworms	15		2.4

Table 1 *(continued)*

Food	Number of occurrences	Percentage frequency
iscs	10	1.6
iles	9	1.4
amnophis (garter snake)	3	0.5
reria (DeKay's snake)	1	0.2
rtle	1	0.2
determined snakes	4	0.6
tation	2	0.3

e present study, muskrats are not common. They do occur in large bers on the larger streams and marshes of central and western York from which specimens were obtained. Of the 34 mink that eaten muskrats, 26 (76.5 per cent) were males and 8 (23.5 per) were females. This tendency for the males to kill muskrats is ubtedly a reflection of their greater strength and greater wan- ig. Some of the muskrats eaten undoubtedly represented carrion apped animals. Similarly, of the 18 mink that had eaten cotton- 15 (83.3 per cent) were males. Other mammals listed were mably taken in proportion to their availability.

HIBIANS

Frogs, principally *Rana pipiens,* are important foods of the mink. r investigators have found these anurans to play a major role in its Some frogs are presumably taken as torpid individuals on the bottom or gravel beds of streams where they winter, since mink ining these foods were trapped at temperatures well below ing. The large ovarian eggs of ranids show little digestion, some g recovered from the hind gut in perfect condition. The ple- ontid salamanders included *Desmognathus* and *Eurycea.* Remains e spotted salamander *(Ambystoma maculatum)* were recovered five animals.

STACEA

Crayfish remains were recovered from 14.1 per cent of the animals, oximating almost exactly the relative frequency (14.06 per cent) ded for Pennsylvania mink by Guilday (1949). Dearborn (1932) ded crayfish in 7.91 per cent of the winter food of Michigan mink, Sealander (1943) recorded them in 6 per cent of 102 stomachs

from December-caught Michigan mink. Two Long Island mink tained the remains of fiddler crabs *(Uca)*.

Insects

A good share of mink food consists of insects, many of which aquatic forms. Both male and female mink appear to utilize in equally. Beetles, principally large dytiscids and their larva, tip larvae, *Chauliodes* larvae and large Plecoptera nymphs were frequently taken (5.4 per cent). Trichoptera larvae were either moved from the cases, or occasionally ingested with part of the cove case. Grasshoppers and hemipterans constituted the remaining i tifiable insects.

Birds

What proportion of the birds eaten by mink constitutes car and what numbers are actually killed by mink is problematical. T occasional depredations on poultry have been documented, and probable that a large male would have little difficulty in killi pheasant or wild duck. Pheasants had been eaten only by male m The undetermined fringillids were represented by feathers and f mentary remains of feet.

Earthworms

This study is the first to demonstrate that earthworms form a of the mink diet. They are overlooked in scats, since only the mi setae would resist digestion.

Molluscs

Planorbids and *Physa* occurred in 15 stomachs and intes tracts. Except for one instance, they were not associated with fis frog remains, and may be considered a primary food organism the mink.

Reptiles

Garter snakes and red-bellied snakes were positively identi Undetermined snakes all had keeled scales, and were probably of t two genera or *Natrix*. Mr. Leo M. Johnson, of Corfu, who supp me with 150 mink carcasses, told me that in his experience mink a great many snakes, but eat only the head. Ventrals and tail snakes were recovered in the present study. A small painted t *(Chrysemys)* had been eaten by one mink.

ETATION

The published accounts of mink foods accord vegetation no part ne natural diet of the mink. It is generally assumed that plant rial is taken inadvertently when animal matter is eaten. Quan- of *Elodea* in two specimens suggest that this aquatic plant was ed for food.

SUMMER FOODS

Data on warm-weather foods of the mink are not so easily secured nose for winter food. Since trapping is done from November igh mid-winter, studies on the summer diet are restricted to scat ses. Many food items are almost entirely digested, or are passed ch small undigested amounts that identification of these fragments her extremely difficult or impossible. The likelihood of confusing nk scat with that of a muskrat which has eaten its own kind is nt (Errington, 1943 . The feces of mink are usually distinctive, may be confused with those of a large weasel. If the scat contains these are usually twisted in a spiral fashion, whereas scats con- ng insect and fish scales are more nearly cylindrical.

The analyses of 300 summer mink scats collected on the Mon- na Marsh of west-central New York have been reported elsewhere milton, 1940). Since then, 261 additional scats have been collected. e were taken on the Spencer Marsh 15 miles south of Ithaca (38 oles), along the banks of Fall and Cascadilla Creeks near Ithaca , the inlet to Long Lake in Hamilton County (73), the Seneca nance Depot in Seneca County (32), and headwater streams e Susquehanna River in Tioga County (65). Many were collected the vantage point of the stream bed, since recesses beneath s, areas about muskrat burrows and the natural culverts that drain

E 2. Summer Foods of New York Mink Based on 561 Scat Analyses

Food	Number of occurrences	Percentage frequency
mals	247	44.0
	182	32.4
ts	164	29.2
hibians	106	18.9
fish	71	12.7
	52	9.3
iles	23	4.1
uscs	4	0.7

Table 3. Combined Summer, Fall and Winter Foods of New York M Based on 1,191 Analyses

Food	Number of occurrences	Percentag frequency
Mammals	456	38.3
Fish	397	33.3
Amphibians	244	20.5
Insects	207	17.4
Crayfish	160	13.4
Birds	69	5.8
Reptiles	32	2.7
Earthworms	15	1.3
Molluscs	14	1.2
Vegetation	2	0.2

into the stream can be explored best in this manner. Cement bri abutments along streams are particularly productive of mink droppi Scats on the Ordnance Depot were found in a pile not far fro woodchuck burrow where a mink was later trapped. From their pearance, it is presumed that all of the scats were reasonably fresh were deposited from June to late September. Analysis of these sc combined with the 300 from the Montezuma Marsh, are listed in Ta 2. These data give a food record of marsh- and stream-inhabiting n from several localities in New York State.

COMBINED SUMMER, FALL AND WINTER MINK FOODS

The records from fall and winter stomachs and intestines and f summer scats, totalling 1,191 occurrences, are combined in Tabl Stomach analyses are more satisfactory than scat examinations s they provide more items that may be determined, but combining results of the two methods of food analyses does present an idea seasonal trends. From these data, one may determine the role of v ous organisms at different seasons.

LITERATURE CITED

Darrow, Robert W. 1947. Predation (Chapter 7). In: The ruffed gro N.Y.S. Cons. Dept.

Dearborn, Ned. 1932. Foods of some predatory fur-bearing animals in Mi gan. Univ. Mich. School of Forestry and Cons. Bull 1.

Errington, Paul L. 1943. An analysis of mink predation upon muskrat northcentral United States. Iowa State Coll. Agr. Exp. Sta. Res. 320: 798-924.

Grimm, William C. and Harvey A. Roberts. 1950. Mammal survey of so western Pennsylvania. Penna. Game Comm.

Guilday, John E. 1949. Winter food of Pennsylvania mink. Penna. G News 20(19): 12, 32.

LTON, W. J., JR. 1936. Food habits of the mink in New York. Jour. Mammal. 17(2): 169.

———. 1940. The summer food of minks and raccoons on the Montezuma marsh. Jour. Wildl. Mgt. 4(1): 80-84.

NDER, JOHN A. 1943. Winter food habits of mink in southern Michigan. our. Wildl. Mgt. 7(4): 411-417.

WATERFOWL BANDING IN NEW YORK[1]

Donald Schierbaum Game Research Investigator
New York State Conservation Department

Dirck Benson Game Research Investigator
New York State Conservation Department

Lee W. DeGraff Game Research Investigator
New York State Conservation Department

Donald D. Foley Game Research Investigator
New York State Conservation Department

ABSTRACT

Waterfowl banding has been done in New York nearly every year 1917. In 1947, an expanded program to band wild stock was undert Trapping stations were located to sample the major population segments the State's water areas. While the great majority of the birds banded marsh ducks, diving ducks were also trapped successfully. In all, 74,139 w fowl were banded from 1945 to 1957, and 10,981 were subsequently re and reported.

From these records, flight routes to and across New York are descr Rates of recapture are discussed. Needs for additional banding work to solve waterfowl management problems are outlined. The trapping and ing methods used are also described.

Waterfowl banding stations have been operated in New York S nearly every year since 1917. Prior to 1945 most were private e prises. Banding by the Conservation Department was sporadic at time and largely involved game farm stock. Growing interes waterfowl problems in the middle 1940's focused attention on the r answers which might be obtained from the reported recoveries o birds that had been banded. In 1945, a Federal Aid project (W-2 was undertaken to organize and correlate the existing banding re pertaining to New York. The results proved quite useful, and indicated that further banding would be desirable. Consequentl expanded waterfowl banding program was begun in 1947.

Most of the earlier banding of wild birds had been done at on Long Island and in the Finger Lakes region, plus a major st at Rochester. The initial summary of band returns had indicated the birds that pass through these areas represent only segmen the waterfowl population of the State as a whole. Therefore, s quent banding operations were designed to include stations in sections to sample portions of the population that had not been tou

[1] A contribution of Federal Aid in Fish and Wildlife Restoration P W-39-R.

he earlier trapping. The primary objectives were to determine major breeding and wintering grounds of the waterfowl passing ugh the State and to gain information on the degree of gunning hich these birds were being subjected. As band returns accumu- l it became obvious that many other problems could be solved, ast partly, through banding, and from time to time in recent years emphasis of trapping activities has been varied to obtain data g these lines.

This paper describes the methods used and summarizes the band- that has been done under this program since 1945 and the recov- that have been reported. From all the data collected, the flight es of waterfowl to and across New York are discussed. The paper suggests problems that merit more study—some through the ing recovery records and some through more specialized banding. intended both to show the present status of the banding program to serve as a background for future work.

LOCATION OF BANDING STATIONS

The principal stations operated in the entire period during which ding has been done are listed in Table 1 and their locations are vn in Figure 1. For the years since 1945 the intention was to locate ons in all the major flight lanes where waterfowl concentrations rred. But, in actual practice, lack of satisfactory terrain for ating traps, excessive human disturbance and unavailability of onnel were limiting factors. In some places, too, although large bers of waterfowl used a water area, they avoided sites where traps d be set. Most of the State-operated stations were tended by per- nel in the employ of the Department, but volunteers also made very iderable contributions especially at Ram Island, Dunkirk Harbor Canandaigua Lake.

TRAPPING METHODS

The trapping methods followed at the various stations were pted both to the main group of species to be taken and to the type tuation in which the traps were to be located.

pping Marsh Ducks

Most of the trapping stations for marsh (or dabbling) ducks e operated from about September 1 until near the start of the ning season. In some situations the traps were kept open until ze-up, while in others, where open water was available, trapping

TABLE 1. PRINCIPAL WATERFOWL BANDING STATIONS OPERATED IN N
YORK STATE FROM 1917 THROUGH 1957

	Location§	Years operated	Major groups		Operator
			Dabbling ducks	Diving ducks	
1.	Southhampton	1927–31	*	..	C. J. Mercer
2.	Ram Island	1949–55	*	*	E. Talmadge & Cons. Dept
3.	Quogue Sanctuary	1935–52	*	..	R. Federico & W. Burding
4.	Riverhead	1932–37	*	..	J. Powers
5.	Carmans River	1951–57	*	..	Cons. Dept.
6.	Oakdale	1926–27	*	..	A. G. Allen
7.	Wantagh	1932–34	*	..	W. Vogt
8.	Hempstead Reservoir	1932–34	*	..	C. R. Weinberg
		1949–50	*	..	Cons. Dept.
		1956–57	*	..	Fish & Wildl. S
9.	Whitestone Bridge	1951–54	*	..	G. Fish
10.	Bronx Zoo	1932–47			
		1951–54	*	..	L. S. Crandall
11.	New York City	prior 1945	*	..	W. R. Wylie
12.	Basic Creek Reservoir	1952–53	*	..	Cons. Dept.
13.	Delmar Game Farm	1936–53	*	..	Cons. Dept.
14.	Niskayuna	1944	*	..	Cons. Dept.
15.	Tomhannock Reservoir	1947–53	*	..	Cons. Dept.
16.	Lake Alice Game Mgt. Area	1946–55	*	..	Cons. Dept.
17.	Black Lake	1945	*	..	Cons. Dept.
18.	Perch Lake Game Mgt. Area	1945–57	*	..	Cons. Dept.
19.	Oneida Lake	1950–57	..	*	Cons. Dept. & Cornell Univ.
20.	Sherburne Game Farm	1935–42	*	..	Cons. Dept.
21.	Ithaca	1917–36	*	*	A. A. Allen
22.	Union Springs	1920–24	*	*	D. Beyea
23.	Canoga	1952–57	*	*	Cons. Dept.
24.	Montezuma Wildlife Refuge	1939–57	*	..	Cons. Dept., F & Wildl. Serv
25.	Howlands Island Game Mgt. Area	1935–36			
		1942–57	*	..	Cons. Dept.
26.	Seneca Lake	1953–57	..	*	Cons. Dept.
27.	Canandaigua Lake	1955–57	..	*	Canandaigua L Duck Club Cons. Dept.‡
28.	Keuka Lake	prior 1945	*	..	V. Burtch
29.	Sodus Marshes	1953–54	*	..	Cons. Dept.
30.	Rochester	1927–42	*	..	W. B. Large, J. H. White
31.	Oak Orchard Game Mgt. Area†	prior 1945	*	..	J. F. Schmidt
		1944–57	*	..	Cons. Dept.
32.	Niagara River	1950–52	*	*	Cons. Dept.
33.	Dunkirk Harbor	1955–57	..	*	North Chautau Fish & Game C for Cons. De

§ Station numbers correspond to those on map in Figure 1.
† Geese were also taken at the Oak Orchard station.
‡ R. L. Case and R. Withington, volunteer operators at the Canandai Lake and Dunkirk Harbor stations, respectively, made especially notewo contributions to the development of methods for trapping diving duck

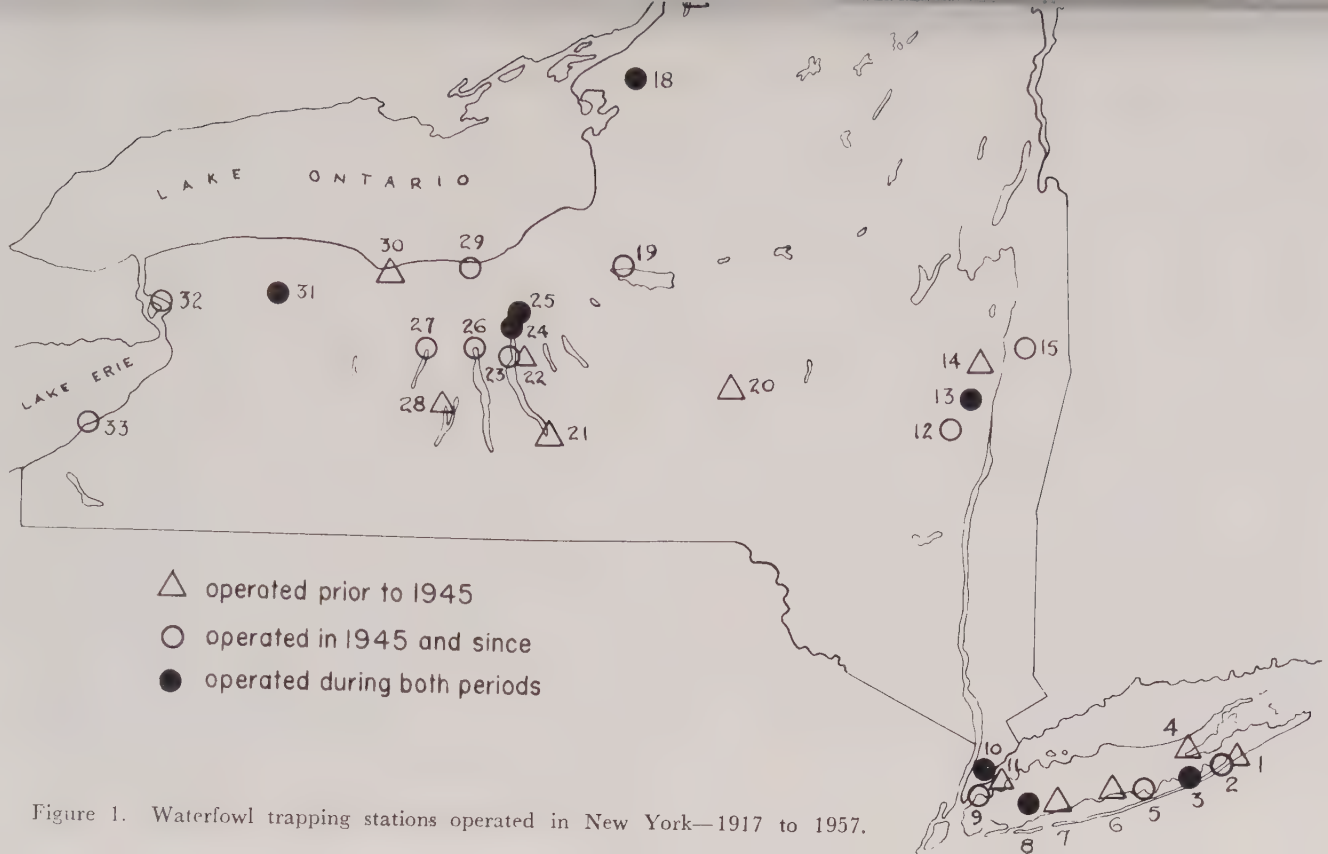


Figure 1. Waterfowl trapping stations operated in New York—1917 to 1957.

was continued to sample wintering populations. Although the tr were designed primarily to take dabbling ducks, a few diving du were captured also.

Many models of traps were tried with varying success. Some w constructed with posts and chicken wire, others with electrically-wel wire of a heavy gauge that stood without posts. The chicken-wire tr varied considerably in size and shape, while those of electrically-wel wire were all about 6 feet square (Kutz, 1945). A trap 4 feet h was found most satisfactory, and both 2 by 4-inch and 1 by 4-i mesh worked well. In most situations the traps were located with entrance at the water's edge, but highly successful traps were opera entirely on dry land also, as well as in 2 to 3 feet of water 100 ya or more from shore. Anchored floating traps on wooden platforms w used also but generally were not quite so successful. A low lea or guide fence, directing the ducks to the trap entrance sometir appeared to be effective.

Three types of trap entrances (Figure 2) were used, each of wh

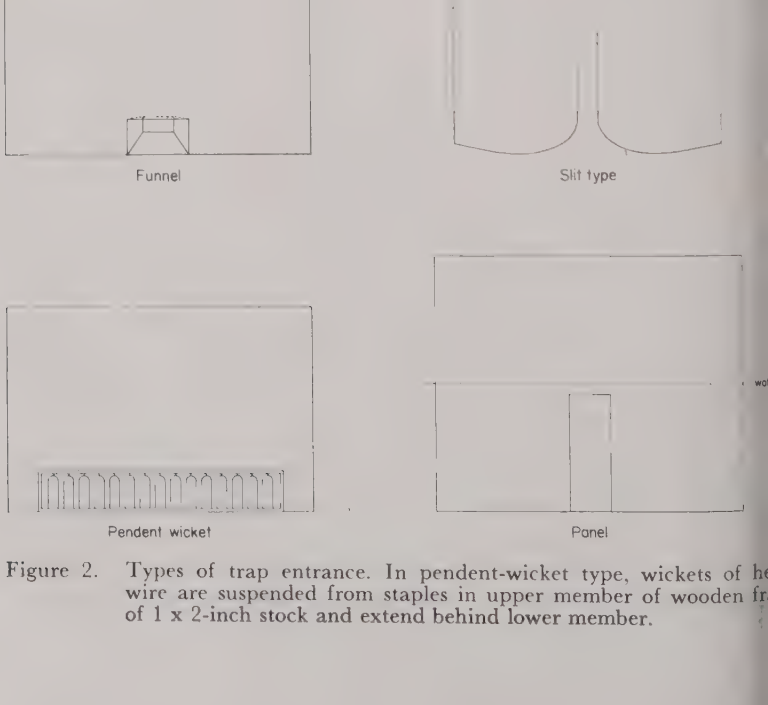


Figure 2. Types of trap entrance. In pendent-wicket type, wickets of h wire are suspended from staples in upper member of wooden fr of 1 x 2-inch stock and extend behind lower member.

merit. The most commonly used was the simple funnel made of ken wire and reinforced with a wicket of heavy-gauge wire that ented the funnel from being mashed down when there were many ks in the trap. The slit type of entrance extending from the top to bottom of the trap proved exceptionally useful both for traps set leep water and in situations where water level changes could be ected. On several occasions rapid rises in water level made funnel ances useless while the slit type still functioned. Usually the slit required less adjustment during the trapping period than the nel type; on the other hand, it appeared that ducks succeeded e frequently in escaping from it. A pendent wicket entrance was used which would open in but not out. In some situations this trap superior to others; however, its high maintenance requirements inated it from greater use.

Corn (ear, whole or cracked) was used most frequently as bait. er baits, such as wheat and buckwheat, worked equally as well, ever.

PPING DIVING DUCKS

Trapping for diving ducks was usually started as soon after the e of the hunting season as possible. At most places this proved to January, and operations were continued into April at some stations.

The trap used for this work was basically that described by ierbaum and Talmage (1954), with a panel 6 or 8 inches wide and nches to 2 feet high cut out of one side. Usually it was set in water p enough so that the opening was 2 to 4 inches below the surface. t success with this trap was obtained when it was set with the ance toward shore or on the lee side; in working the wire and ng to try to escape, caught ducks most commonly stayed on the n-water side and rarely found the entrance. In some instances rt wings were placed inside a trap to divert the ducks from escaping, this appeared to have little effect. Where it was necessary to place os in water shallower than the height of the opening, a tube of vy wire having the same dimensions in cross-section as the entrance per was extended inward about 15 inches.

Generally, little difficulty was encountered in inducing diving ks to start coming to a trap, even when it was within 15 feet of re. Various grains were tried and proved effective as bait, but eat seemed the most satisfactory. With wheat it took longer for ducks to clean up what was put out and problems from gorging

were less frequent. Often the ducks were very tired when remov from a trap, and those that had gorged on whole-kernel corn frequen had difficulties after being released.

Fewer losses following banding occurred when tired ducks we held for a while in either dark boxes or bags. A chicken crate, lin with burlap and mounted on a truck innertube, proved an excelle and convenient floating holding box while ducks were being dipp from a trap.

Use of Cannon Net

Cannon nets have been used primarily for trapping geese in t spring, but they have been used occasionally to take ducks as we Both single nets and two nets facing each other have been used. T latter arrangement assured greater success but also required mo personnel to remove the geese before some strangled themselves. Re tively few losses, however, were suffered with either set-up. A comb nation of ear corn, shelled corn and wheat was used as bait. Son success was had in luring birds to upland sites, but the most reliab type of site was where a narrow arm of shallow water stretched into field maintained as cropland.

Trapping Flightless Young

Only a limited amount of attention was given to banding loca produced young still in the flightless stage. Two trapping metho were tried. Drive trapping did not prove very satisfactory, becau of both insufficient personnel and the lack of large concentratio of waterfowl. Marsh duck traps having either funnel or slit entranc were operated effectively with wheat as bait, but the rate of succ was lower than that for full-grown birds later in the season. Trappi was done during July and early August.

IDENTIFICATION OF SPECIES, SEX AND AGE

Most personnel could correctly identify the species of waterfo that were handled, but those who could reliably determine sex and a were more difficult to find. To begin with, age was not recorded, a sex was judged only by voice and external characteristics. Probab few errors were made in separating male and female adults in breedi plumage. But, when cloacal examinations were used as standard pr cedure, it became obvious that errors had previously been made determining the sex of immature ducks. Age determinations, other th by external appearance, were not made until 1950, and it was n

il 1952 that a definite effort was made to have all waterfowl that e trapped in late summer and fall checked for both age and sex by cal examination. Cloacal examinations are now made of some of winter-trapped ducks, but information on age is not especially ortant at this season, and proves decreasingly reliable as the winter ances and the young birds approach maturity.

HANDLING THE RECORDS

All waterfowl banding in New York is carried out under the ulti- e jurisdiction of the U. S. Fish and Wildlife Service. The disposi- of bands and handling of banding records have been described by son (1947). The essential steps upon the receipt of records from field are: (1) check for obvious errors and omissions, (2) enter for each band in the master index book, (3) prepare schedules the U. S. Fish and Wildlife Service, (4) prepare monthly summary ts for each station, and (5) prepare a record of the birds retrapped each station. These steps are routine, but a large amount of corre- ndence is necessary to keep the records clear and accurate. In ition, for some stations complete records of all ducks taken more n once have been kept, and these have been cross-indexed back to date of banding.

Band returns come mainly through the U. S. Fish and Wildlife ice as reported by hunters or other interested individuals. Simi- , reports turned in directly to the Department, including those banded birds recaptured at banding stations, are funneled through Fish and Wildlife Service and are considered for tabulation and lysis only after having been processed by the Service. Recovery a from this organization are sent to the Department in two forms: an IBM card coded and punched to include the complete banding recovery history of the bird; (2) a copy of the form letter sent to individual who reported the recovery, giving essentially the same rmation as (1). The file of IBM cards is maintained as a source of ulations of data that may be desired for the study of various water- l problems, and its arrangement is not constant. The form letters, "thinsies" as they are called, are maintained in separate files in r of the year of recovery (for this purpose a year begins July 1). se for birds banded in New York are also grouped by station. addition, the Fish and Wildlife Service furnishes the State with es of reported recoveries within New York of waterfowl banded where. A separate file of these records is maintained.

WATERFOWL BANDED AND RECOVERIES REPORTED

In all, 74,139 waterfowl were banded from 1945 through 19 and 10,981 had been subsequently reported as of June 30, 1958. T latter are accumulative records from all sources including hunting, bi found dead, and those retrapped. The data are summarized in Table

Figure 3 illustrates the distribution of the points where banc waterfowl have been retaken and the relative frequency of these rec tures in the different parts of the area involved. That New York fundamentally a part of the Atlantic Flyway is evident. Spanning

Table 2. Waterfowl Banded in New York During the Calendar Ye 1945 through 1957 and Those Subsequently Reported as June 30, 1958

Species	Number banded	Total reported		Reported from New Y	
		Number	Per cent	Number	Per cent
Dabbling ducks					
Black duck	33,134	5,888	17.8	3,439	58.4
Mallard	10,578	1,850	17.5	850	45.9
Wood duck	6,034	740	12.3	345	46.6
Pintail	707	72	10.2	46	63.9
Blue-winged teal	458	45	9.8	18	40.0
Green-winged teal	82	4	4.9	1	25.0
Baldpate	45	13	28.9	2	15.4
Shoveller	12	..	..	..	.
Diving ducks					
Canvasback	7,232	763	10.6	336	44.0
Redhead	6,305	870	13.8	388	44.6
Lesser scaup	3,539	340	9.6	114	33.5
Greater scaup	2,866	134	4.7	63	47.0
Ring-necked duck	207	33	15.9	1	3.0
Bufflehead	202	34	16.8	17	50.0
American goldeneye	63	2	3.2	..	..
Ruddy duck	4	..	..	..	..
Old squaw	1	..	..	..	..
White-winged scoter	1	..	..	..	..
Geese					
Canada goose	2,036	193	9.5	11	5.7
American brant	1	..	..	..	.
Mergansers					
Red-breasted	630	..	..	..	..
American	1	..	..	..	..
Hooded	1	..	..	..	..

* Of the total reported.

re 3. Area over which waterfowl banded in New York have been retaken showing relative frequency of such recoveries.

constricted part of the Flyway, from the Atlantic Ocean nearly Ohio which is part of the Mississippi Flyway, this State serves as a el or crossroads for most of the waterfowl going further south in it. exceptions are chiefly those birds that work eastward over the A. lakes or into Florida from the southern portion of the Missis-

sippi Flyway, or which may fly non-stop from Wisconsin, Minne or Michigan to Chesapeake Bay.

The records also indicate the average dates of arrival of cer duck populations, the distribution of the harvest, and some of the fli vagaries which may be induced by various causes. Probably most portant, they illustrate that some of our earlier concepts were ba on only partial knowledge and that still more data will have to amassed to solve certain management problems.

Important to management is the extent to which hunters s from one zone to another in the State to take advantage of season da Information from banding records and hunter bag checks has indica that no more than 30 per cent, and perhaps as few as 10 per cent New York's waterfowlers travel more than 25 miles from home hunt (Schierbaum and Foley, 1955).

FLIGHT ROUTES TO AND ACROSS NEW YORK

Band returns to date suggest that ducks arriving in New Y may come from almost any part of their North American range, that the majority come from those portions nearest New York or wit a "logical" flight lane. A "logical" flight lane is one where topogra is favorable; ducks seem to follow sequences of attractive water ar and they may tend to avoid crossing heights of land although mounta apparently are not the deterrent they were once assumed to be. Or route may be ancestral—at least it is difficult to account other for ducks, especially the greater scaup, that breed across north Alaska and eventually cross New York in their southward migrati Also difficult to explain are both the marsh and diving ducks that reared in the Prairie Provinces but that come to or through New Y when we know that other ducks raised in the same township, or perh the same marsh, may disperse to the Pacific, Central or Mississi Flyways. Equally confusing are some of the redheads that follow alm an east-west course to winter in New York.

The black duck, still the principal game duck in New York, tho in recent years the mallard has increased in importance, feeds i the State from all parts of its range. The western and central porti of the State receive birds chiefly from Ontario and western Que while in the Champlain and Hudson valleys they come largely fr Quebec. Black ducks arriving on Long Island come mainly down Atlantic Coast from New England, the Maritimes and Labrador, their numbers are supplemented by some birds from Quebec Ontario.

Wood ducks reach New York only from the southern fringe of the just described. Other marsh ducks come largely from the Prairie inces and the Plains States. The latter applies to the majority of living ducks, with Alaska, the Yukon and the Northwest Territories her points of origin.

As of the present time no data satisfactorily demonstrate the rela- proportions of our total birds that come from these different ns or how they compare in numbers with those produced in New . Cooperative summer banding in Canada is an approach to roblem, but adequate records have not yet accumulated.

The wintering grounds for waterfowl banded in New York stretch e way from Lake Erie, Lake Ontario and the St. Lawrence River ward through the Finger Lakes and the Champlain-Hudson y to the southern Atlantic Flyway states. The blue-winged teal some others push on through the West Indies and into northern h America. Some black ducks and wood ducks angle southwest swell the wintering populations of the Mississippi Flyway. Data cted so far indicate that wintering areas for some species may not o restricted -for example, diving ducks apparently trade back forth to some extent during the winter between our Finger Lakes the Chesapeake and Delaware Bays. On the other hand, black s on Long Island do very little moving around in mid-winter. Specific flight lanes within New York are less well-defined, and derably more crisscrossing of flights takes place than was once ved. Broadly speaking, the State is crossed by three main routes— along the Atlantic Coast that merely crosses Long Island, one n the Champlain-Hudson valley, and one in western and central York. But that does not tell the whole story.

Long Island receives most of its marsh ducks from the coastal t and is a wintering ground for many; it is a resting area for rs that later continue further south along the coast. It also ves some of the ducks that have followed the Champlain-Hudson Connecticut valley lanes. Band returns do not make clear the e followed by the diving ducks that frequent this region. At least probably arrive by an overland route with their last previous perhaps on Lake Ontario or the St. Lawrence River.

The Champlain-Hudson flight lane receives little supplementation it reaches New York. Band returns suggest that some ducks, but ably very few, feed into this flight via the Mohawk valley. There no banding records to indicate either the source or the destination

of the ducks using the numerous Adirondack waterways or the o sional large flights that are observed passing overhead. Band rec suggest a split at the lower end of the Hudson Valley. Some b swing off southwestward at Kingston to follow the old Delaware Hudson Canal and eventually reach Delaware Bay; others cont downriver with some stopping at Long Island; still others follow coast southward. The majority (mostly black ducks) winter in Chesapeake and Delaware Bays, probably more densely in the la

The western or central flight lane is really the crisscrossin many duck groups with different origins and destinations. Ther some evidence, too, to indicate that weather and other factors (perh chance, perhaps feeding conditions) may vary these flights. S groups of ducks, including both divers and marsh species appare from the Prairie Provinces, touch only briefly along the shores of L Erie or Chautauqua Lake before continuing to the Chesapeake points south. Others pass through New York more leisurely, follow Lake Ontario to its eastern end and eventually dropping down the Finger Lakes region to winter or to use it as a stopover before ceeding farther south. And it appears that, enroute along Lake Onta various segments drop off to the assorted inland marshes. At the sa time other birds from eastern Ontario and western Quebec move central and western New York. The vast majority of the ducks pass through this half of the State eventually find their way to Ch peake Bay and farther south along the coast. However, one segm follows a southwesterly course across New York to the Ohio Va and the lower Mississippi Flyway. Approximately 20 per cent of black ducks banded at Rochester and taken farther south follow this southwesterly route. Recoveries from farther north indicate population probably came largely from eastern Ontario and west Quebec.

Examination of records from individual stations for recoveries birds banded in late summer or fall strongly suggests that duck mo ment is not so much a gradual southward movement as it is a "le frog" process. For example, bandings at Lake Alice gave a few lo recoveries and many in states farther south; yet they hopped right o the Tomhannock-Vischers Ferry region near Albany which is the m major duck concentration area to the south. Similarly, large numb of marsh ducks banded at Oshawa, Ontario, provided practically recoveries in New York waters just across Lake Ontario.

DEGREE OF RECOVERY

In considering the records for banded waterfowl retaken (Table 2) ould be pointed out that some 90 per cent of the marsh ducks banded prior to 1955. Hence, the recoveries reported for this represent most of those that are likely to be forthcoming. Also, stantial proportion of these ducks were banded during summer or fall and thus provided many direct recoveries.[1] Usually, direct eries outnumber indirect recoveries.

Among the marsh ducks, only for the mallard, black duck and duck were large enough samples banded to provide a good pic- of the recoveries to be expected. The degree (over 17 per cent) almost identical for mallards and black ducks. The lower return per cent) for wood ducks probably reflects the fact that, because earlier fall migration, this species is less subject to gunning. The appears to be true for pintails and blue-winged teal, also early ants, as has been suggested by Low (1957).

Among the diving ducks, reasonably large samples were banded for edhead, canvasback and the two scaups. The rates of recovery, ver, are not fully comparable with those for the marsh ducks se the birds were banded in late winter after the hunting season had to pass through a breeding season before being subjected to ing. Studies of both waterfowl and other species have frequently ated sizable losses during the breeding season. Thus, to be com- ble, the percentages shown in Table 2 would have to be adjusted rd. How much is not known. A more detailed analysis of the data s desirable.

Of the total recoveries, the proportion taken in New York varied een 40 and 50 per cent for most of the species that were banded in antial numbers. The two exceptions were the lesser scaup and the duck, for which the figures were about 36 and 58 per cent, ctively. Time and location of banding influence such data; and of the work reported here involved wintering populations. For of the species it would seem that gunners in New York are obtain- reasonable share of the harvest of the stock that is present in the long enough to be subject to trapping. These data, also, merit er study.

The number of geese banded was not large, yet the records show important points. First, geese banded in New York are being

[1] direct recovery is one prior to the first breeding season after the bird was ded; an indirect recovery is one after an intervening breeding season.

subjected to relatively heavy hunting pressure since the returns (per cent) were all indirect and all but nine of them were by gunni Nearly all the geese banded had been trapped in the spring wi enroute to their breeding grounds. Second, only about 6 per cent of harvest occurred within the State. Most of those shot were taken in James Bay region to the north or near their wintering grounds in Ch apeake Bay and North Carolina. Either few stop in New York in fall or, if they do, they are unavailable to the gunner.

DISCUSSION

The data accumulated so far indicate in a broad way the breed and wintering grounds of the waterfowl that stop off in New Y and their main lines of flight. They provide greater detail for black duck, mallard and wood duck. The records also show the proximate proportions of the populations that are harvested, within State and elsewhere. This is important knowledge for guiding mana ment policy in this State and relating it to policies in the other st and provinces in the Atlantic Flyway. The findings further empha that the sport of waterfowl hunting is largely dependent on mut cooperation.

Much more needs to be learned, however, either from more tailed analysis of existing records or by additional, more speciali banding operations. Some of these topics may be mentioned brie

Aerial survey records showing the peaks of waterfowl abunda during the fall months have been used as the primary guide in rec mending dates for the open season. Data from banding work sug that, in their southward migration, marsh ducks tend to stop off only a relatively short time on the various water areas enroute rega less of whether hunting is going on or not. Further study may indic that management can be adapted to this behavior, either in the fo of longer hunting seasons or by varying the opening date so that ferent segments of the population may be subjected to the brunt opening day.

A corollary to the pattern of migration is the fact that sc species of waterfowl are better adapted than others to changing c ditions and pressures. Consequently, management tailored to status and behavior of individual species must eventually be consider This will, in part, involve hunting regulations. Prerequisite to s management are life equation tables which show the annual populat turnover. Records now available afford much data of this kind

ie species, primarily the black duck and wood duck; but for others le banding is needed.

. Knowledge of sex and age ratios is an aid to understanding popu- on changes. Schierbaum and Foley (1957) found juvenile black ks to be more vulnerable generally to gunning than adults, and s to be somewhat more vulnerable than females. Other factors may result in disproportionate take by hunting are suggested by trapping experience of Benson and Cummings (1956). Returns n banding in late summer and fall since 1952 provide good sex age records for further study.

So far, New York band returns have been examined more in re- on to geography than to time. Preliminary study of dates of banding recovery suggests that the time factor may be worthy of more de- d analysis. One possible result might be the development of man- nent practices that would allow more equitable harvest of many ies less pressure on some and more on others. Initially, such ies could be based on the records already available, but additional ding would have to be planned to sample certain population seg- ts not now adequately represented.

Another important consideration is how much management effort ld be devoted to improving conditions for transient waterfowl pared with the share which should be spent on breeding grounds in the State. Field investigations have shown that the many man- le wildlife marshes are quite productive (Benson and Foley, 1956) that some types of large management areas also produce many ks. Few ducks known to have been produced locally have been ded, however, so that evaluation of the contribution of these shes to the New York hunter is still in a rather nebulous state. iminary work along this line (Cummings, 1955) has demonstrated hods by which flightless young may be trapped. Now larger samples called for. Greater emphasis on banding in the North should also l light on this problem.

Associated with the banding of flightless young, questions have n concerning the accuracy of ground surveys of brood abundance, extent to which broods move from one water unit to another in York habitat, and the relative importance of temporary natural r units and man-made potholes to the more permanent wildlife shes. These points all merit consideration in the assignment of agement funds, but they cannot readily be evaluated without more nsive banding of flightless young.

Large numbers of diving ducks were not banded in New York unt 1955, though successful techniques had been developed somewha earlier (Schierbaum and Talmage, 1954). Until more recoveries hav accumulated little may be said, but it seems evident that more bandin will be needed to solve many current management problems. On such problem concerns the amount of hunting pressure to which appar ently late arrivals are subject.

LITERATURE CITED

Benson, D. and G. E. Cummings. 1956. Some implications of waterfow trapping records from the Oak Orchard Game Management Area. N. Y Fish and Game Jour. 3(2):205-216.

Benson, D. and D. Foley. 1956. Waterfowl use of small, man-made wil life marshes in New York State. N. Y. Fish and Game Jour. 3(2):217-22

Cummings, G. E. 1955. Small marshes. N. Y. Conservationist. 10(2):15.

Kutz, H. L. 1945. An improved game bird trap. Jour. Wildl. Mgt. 9(1):35-3

Low, S. H. 1957. Waterfowl banding in the Canadian prairie provinces. U. Dept. Int., Fish and Wildl. Serv. Spec. Sci. Rep. Wildl. No. 36.

Mason, Charles I. 1947. Organization and correlation of New York wate fowl banding records. Fed. Aid Project W-21-R. Final Report (mimeo. N. Y. Cons. Dept.

Schierbaum, D. and E. Talmage. 1954. A successful diving duck trap. N. Y Fish and Game Jour. 1(1):116-117.

Schierbaum, D. L. and D. D. Foley. 1955. Movement of waterfowl hunte in New York State. N. Y. Fish and Game Jour. 2(2):232-238.

———. 1957. Differential age and sex vulnerability of the black duc to gunning. N. Y. Fish and Game Jour. 4(1):88-91.

HE HABITAT MAP: A BASIS FOR WILDLIFE MANAGEMENT[1]

Maurice M. Alexander Assistant Professor of Forest Zoology
State University College of Forestry
at Syracuse University

ABSTRACT

The importance of a cover or habitat map in wildlife management is well wn. However, there are but a few available mapping techniques that are ially designed for use by wildlife managers. There is a definite need for her work on this basic subject.

A system of habitat classification and mapping was developed on an area entral New York. This system is based on a successive breakdown of habi- types in different degrees of detail. This permits the easy comparison of two areas even though they may not have been mapped in the same detail. technique as described is simple in its application, requires only a mod- e amount of time and expense, and is sufficiently flexible to be used under ous conditions.

Textbooks on wildlife management usually contain statements arding the importance of a good cover map. Such a map needs to more than just a cover map because it also should indicate as many ossible of the other wildlife requirements that are furnished by the itat. The name "habitat map" seems more appropriate.

There seems to be general agreement that maps designed for forest arm management are inadequate for wildlife management. This is to omission of the smaller habitats, understories, non-economic ures, and other seemingly minor characteristics of an area that are n of considerable importance to wildlife. In developing a habitat the wildlife manager becomes well acquainted with the area. en he finishes, he will have a map and much data on the topogra-, drainage, soils, vegetation, and water. He will have information on at exists on the area, how much, where, and the arrangement. These important background items that form a basis for management.

However, when one asks how a map of this sort should be made, answer is not easily found, although a few techniques have been ribed (Anonymous, 1944; Arnold, 1946; Bump *et al.*, 1947; ke, 1937, 1941; Graham, 1945; Guthe and McMurry, 1930; pold, 1933; Webb, 1942; Wight, 1934; Wilson and Berard, 1952). easoned manager may have learned through experience, but the lent or beginning manager has a problem. He usually recognizes

rateful acknowledgement is made of the assistance given by the graduate udents in wildlife management at the State University College of Forestry uring the period of developing the field-mapping procedures.

the fact that a poor beginning may lead to poor management. An id method would be one embodying a uniform basic procedure a permitting an area to be mapped with whatever degree of detail m be desired for a particular purpose. Maps of different areas wou then be comparable at corresponding degrees of detail, whether p pared by one worker or by several.

Need for a habitat map arose when the Tully Forest, a prope of the State University College of Forestry, was chosen for multiple-u management of both forests and wildlife. This area in central N York included abandoned land in various stages of reversion, for plantations of several species and age classes, old woodlots manag diversely, and many small habitats such as old roads, fire breaks, hon sites, and fencerows. A forest map showing boundaries, working co partments, forest types, and timber estimates was available. This w useful but it was evident that a more detailed habitat map would necessary.

After studying the published mapping techniques and trying ma new ideas, a procedure was developed in 1953 that was believed to quite simple, easy to apply on different areas, comparatively inexp sive, and still capable of furnishing information of considerable de and accuracy. It required minimum training of personnel, and variation between the work of several field men was not conside serious. The period since 1953 has furnished time for study, examination, and refinement of the technique.

HABITAT CLASSIFICATION

One of the basic premises made in this study was that there ex an almost limitless possible breakdown of habitat types. Just how this breakdown should go depends on the specific area and the obj tives of the manager. If different degrees of detail are to be used different areas, then there should be some organization of the ty so that comparisons may still be made. The question was asked i would not be feasible to break down the types successively in much same fashion as is done in the identification keys for plants and anim This seemed to meet the need for simplicity. In such an approa the broad type groups present are defined first. These can be divi into sub-types and, if necessary, into species types. In this way, level of detail can be used for typing an area, and it would be possi to make comparisons with another area even though it was ty at a different level.

A classification of habitat types in central New York that pro

seful is given in Table 1. It contains five type groups, each with ree basic types and these with two or three sub-types. Species types ould be too numerous to list and were used in this study only to a mited extent. It was quite apparent that, as the typing became more etailed, the accuracy was correspondingly reduced due to greater ariations in the detailed species composition. Additional type groups, r sub-types, might be necessary for other sections of the State.

To permit the inclusion of vegetative form and age, each of the yped areas with plant growth is given one or more numbers that can be laced on the map. The numbers, one through six, indicate form and ge as follows:

1. Herbaceous
2. Shrubs
3. Trees—sapling (in "C" group, equals 1, 2, & 3)
4. Trees—pole (4-8 inches dbh.)
5. Trees—mature (over 8 inches dbh.)
6. Trees all age (equals 3, 4, & 5 in all except "C" group where it equals 1-5)

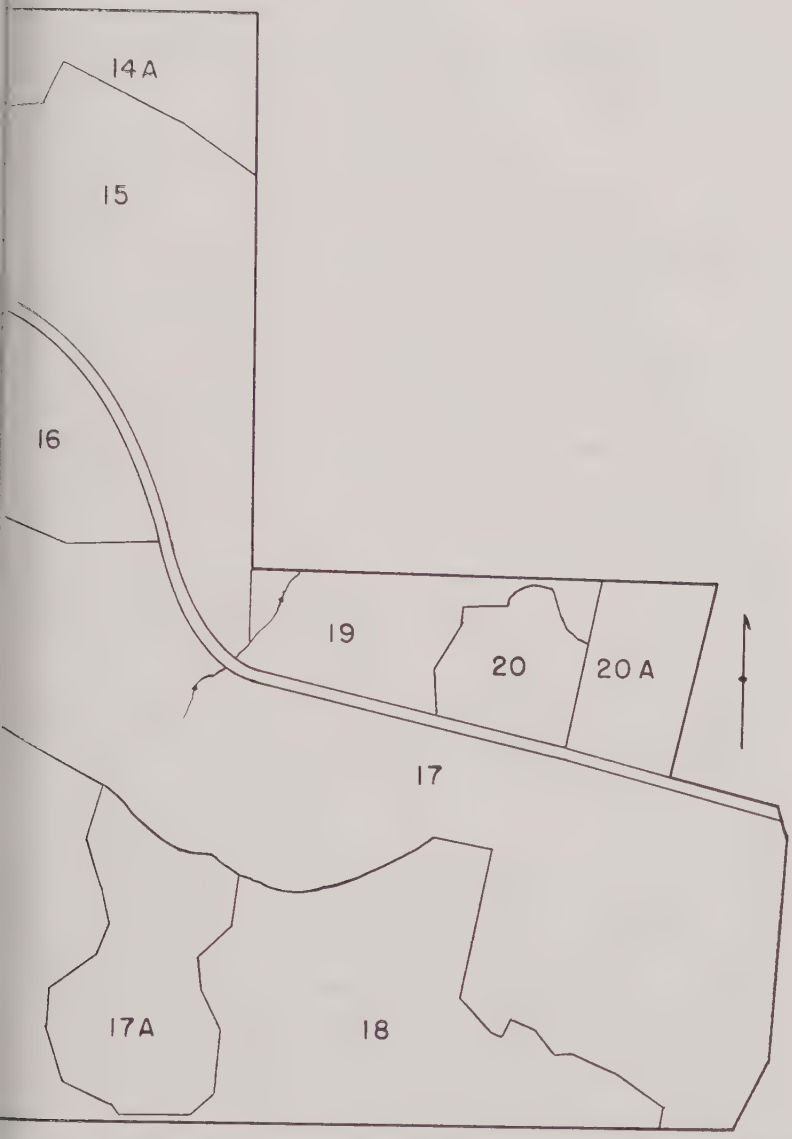
FIELD PROCEDURE

The first step in preparing a habitat map is to obtain an accurate oundary survey. One should be made if none is available. This should e at a convenient scale such as five chains to the inch, certainly no nore than ten chains to the inch. If the area is large, it should be ivided into convenient working units by lines along conspicuous atural features. Field work is made easier by cutting the base map nto sections about 8 by 10 inches (Figure 1) so that they will fit in a lip board. They can be cut along the dividing lines with one to everal units on each sheet.

Establishment of the unit boundaries is greatly facilitated by sing aerial photographs, preferably the most recent ones available. The common 9- by 9-inch pictures with normal overlap between pictures and flight lines are suitable. If complete coverage is obtained, all of the area to be mapped can be found in the central part of the photographs where distortion is at a minimum. By using a baloptican or opaque projector, this center portion can be projected to fit the ase map. The roads, fencerows, woods margins, and plantations can e drawn in quite accurately. These become easily recognized unit oundaries. The dividing lines for extensive forest areas would be the tream beds, ridge lines, and fire lanes.

Table 1. Habitat Type Classification

Initial division	Type group	Basic type	Sub-type	Species type
I. Vegetation mostly woody (forests or abandoned land)	A. Hardwoods	1. Mixed hardwoods	a. Northern hardwoods	This is the last feasible breakdown of types. There could be two to several species types in each sub-type. This level is left for the manager to classify, if he should need this much detail.
			b. Central hardwoods	
		2. Hardwoods with conifer understory	a. Natural conifers	
			b. Planted conifers	
		3. Hardwood swamp	a. Red maple—elm	
			b. Alder—willow	
	B. Conifers	1. Natural	a. Conifer swamp	
			b. Upland conifer	
		2. Plantation	a. Pure	
			b. Mixed	
		3. Plantation with hardwood understory	a. Climax hardwoods	
			b. Temporary hardwoods	
	C. Successional	1. Old field	a. Old field	
			b. Forest opening	
			c. Right-of-way	
		2. Homestead	a. Homesite	
			b. Orchard	
		3. Fencerow	a. Fencerow	
			b. Roadside	
II. Vegetation mostly non-woody (farms or open areas)	A. Terrestrial	1. Cultivated	a. Plowed and cropped	
			b. Hay	
		2. Range	a. Permanent pasture	
			b. Other range	
		3. Barren	a. Exposed rock	
			b. Sand or gravel	
			c. Road or structure	
	B. Aquatic	1. Marsh	a. Sodded	
			b. Emergent	
		2. Standing water	a. Bog	
			b. Pond	
			c. Lake	
			d. Brook	



igure 1. Base map of a portion of the Tully Forest showing working units. Scale: 1 inch = 8 chains.

Stereo pairs of the aerial photographs may be placed in a clip oard and taken into the field with a hand stereo-viewer. Many points confusion concerning topography, vegetation, and the shape of

fields can be clarified by studying these stereo pairs. Sometimes
is the only way of locating features such as small openings in the fo
or of quickly determining the irregular shape of a clearing or a br
patch.

THE TULLY FOREST

AREA NUMBER 18 - 1

BASIC TYPE Mixed hardwoods

Age All age

Descriptive Statement A narrow strips of variable
mixed hardwoods.

OVERSTORY (Species with estimated percentages) 100 % covered

Sugar maple (80 %)
Beech (10%)
White ash
Elm
Butternut Basswood

UNDERSTORY (Or shrubs) 15 % covered

Sugar maple
Striped Maple
Alternate leaved dogwood

GROUND COVER (The more abundant or important species) 50 % covere

Goldenrod Sedge
Ash seedlings Grass
Sugar maple seedlings Trillium
Strawberry Blue cohash
Buttercups

REMARKS

Some logging slash along boundar
from adjoining property.

DATE 6/22/53 CREW M. M. A. & J. C. D.

Figure 2. A sample of the form used in describing the habitat types.

The field work can be done either by a single person or by small crews. Prepared forms (Figure 2) help to standardize and simplify the procedure. When the area is subdivided into units, each should be given a number or other designation. This should appear at the top of each description sheet prepared for that unit. It is followed by another number identifying the portion of the unit being described. These latter numbers are assigned consecutively as the types are described; habitat "21-6" would indicate the sixth habitat described in Unit 21.

The field man, upon entering a unit, describes the habitat at that particular point, determines its extent by pacing and using a compass if necessary, sketches it to scale on the map, and inserts the number "1" on the sheet and on the map (Figure 3). If he desires, he can check his type boundary line by studying the aerial photographs. He then moves to the next (number 2) habitat, etc. This continues until all habitats in the unit have been described and outlined on the map. Some system should be used in covering a unit. One of the best is to work around the outside before doing the interior. It is believed that this aids in plotting the internal type boundaries accurately. The numbers placed on the field map are locator or reference numbers only and will not be found on the finished map.

The field man should completely fill the form for each habitat. He should determine the basic type and the age of woody vegetation, and fill in a descriptive statement of the type. The latter is of great assistance in the office work particularly in coordinating the work of several field men. The vegetation is recorded under three headings—overstory, understory, and ground cover. The overstory species are listed with estimated percentages and sometimes average diameters. This likewise may be done for the understory if desired. Understory also includes shrubs and brush where no overstory exists. It is often impractical to include all the species in the ground cover; therefore only the more abundant or the important ones are listed. The total percentage of cover for each of the three categories is indicated at the right of each title. The "Remarks" space gives the field man a place to add anything that he feels to be important or of interest. Each sheet is dated and initialed.

MAKING THE MAP

Office work on the map can be started after the first section has been completed, or it can be delayed until all the sections are finished. Each habitat type that has been described and sketched can be transferred from the field sheets to a master map of the same scale with the

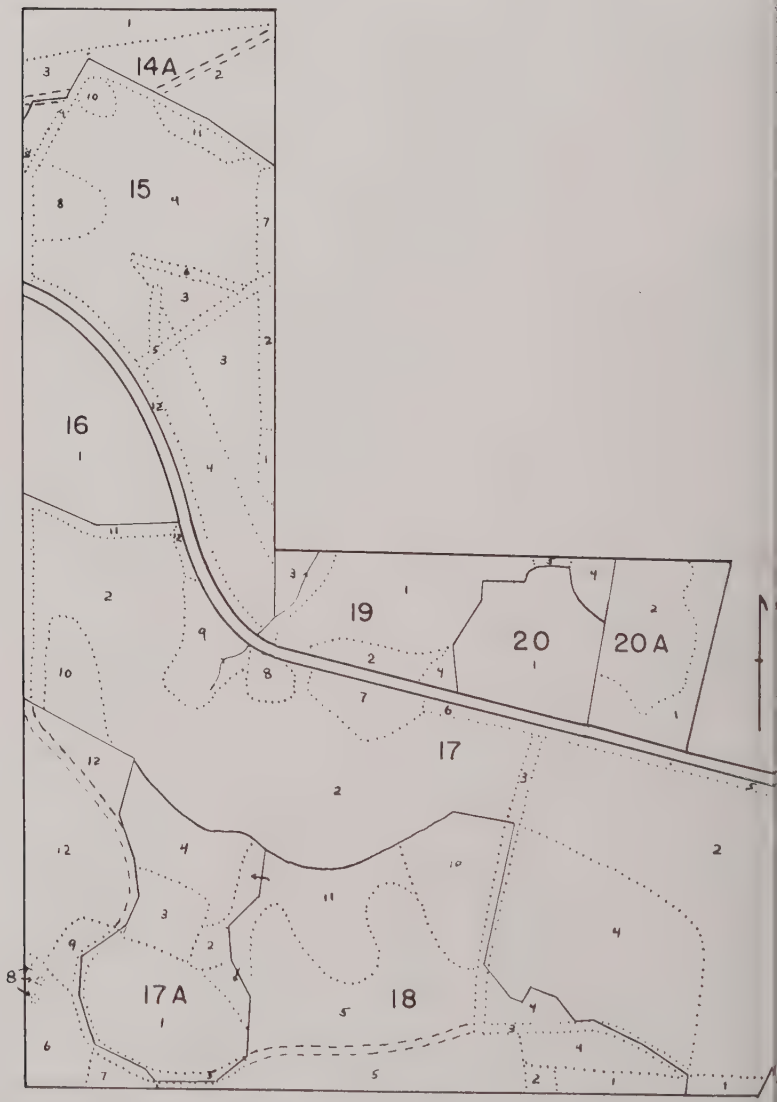
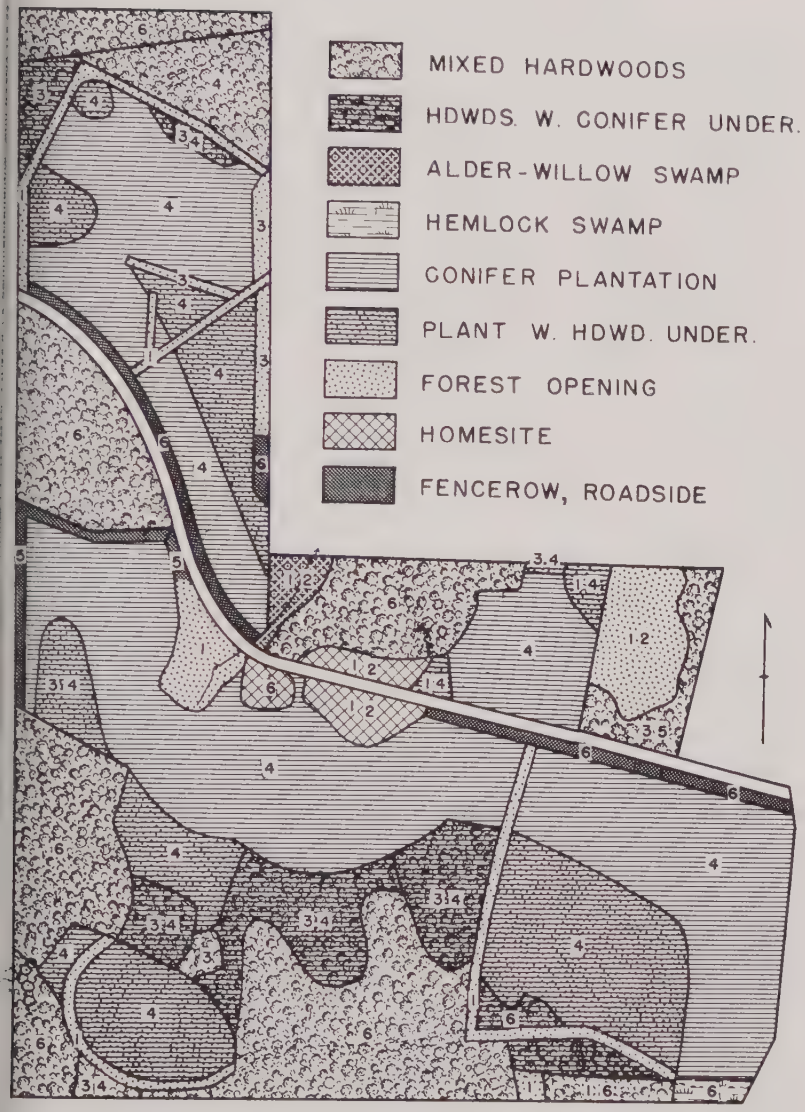


Figure 3. The same area shown in Figure 1 with each unit divided habitat types. The small numbers are added in the field and se as an index to the serially numbered description sheets.

aid of a tracing table. The procedure from here on depends on desires of the manager. He may desire one complete map with all the field numbers on it for quick reference to the data sheets a



igure 4. The finished habitat map of the same area with vegetative form indicated. Note the absence of the serial numbers included in Figure 3.

nother indicating the habitat classification. The latter may be gen-ralized or in detail. He may want it in color, or in black and white or easier reproduction.

Assuming there were three type groups of three types each on area, nine colors would be necessary to show them all. Age and fo could be indicated on the map by placing a colored number in t center of each typed area.

Frequently a large area of one type, such as mixed hardwoo would be divided into many habitats having different age numb for each. Occasionally the age numbers, also, would be the same, dicating that the difference was within the limits of variation of bo type and age but was believed to be sufficiently important to warra separate description. If the map had been based on sub-types or spec types, the separation would be clearer but the number of colors symbols would increase accordingly.

Most managers want a map that can be reproduced by one of t common methods. This requires symbols in place of color and can done easily with the aid of prepared sheets of overlay symbols su as Zip-A-Tone. Here again, with each increase in the number of typ shown, the job becomes more difficult. However, about a dozen typ can usually be handled without confusion. Type boundaries wo have to be made heavy enough to separate the symbols clearly. A and form symbols can be used if the manager wishes. A portion of finished map is shown in Figure 4.

The area of each habitat type can be determined by using planimeter when the map is completed. Totals for each type or ty group can be obtained and pencentages calculated. The manager c refer to the field data sheet of any particular habitat for details n shown on the map.

DISCUSSION

This method of habitat mapping is believed to be sufficien flexible so that it can be used as a basis for either a very generaliz map or a detailed one from the same data. It is more than a fie sketch based on quick reconnaissance, and it does not require t time and expense of a detailed quantitative vegetation study. Types a easily redescribed as successional or management changes occur. avoids cumbersome symbols, and the distribution of habitat types can easily visualized by a glance at the map.

The work entailed is relatively inexpensive. Although great vari tions in cost may be expected for mapping different areas, it is believ that 60 to 100 acres can be field-mapped per man-day under avera conditions in central New York. Office work on the map would about as fast. Areas of uniform age and composition would be mapp

more cheaply than others such as wet bottomlands with their complex habitats.

The value received from a habitat map in wildlife management is a continuous asset. It serves as a basis for management and is a contributing factor throughout. If maintained, it records habitat changes and the results of management. Attempting management without a map is poor planning.

LITERATURE CITED

ANONYMOUS. 1944. Game cover types in New York State. Bureau of Game Cir. No. 4, N. Y. S. Cons. Dept. (mimeo.)

ARNOLD, MILTON C. 1946. Cover mapping for forest and wildlife management in Connecticut. Trans. 11th N. A. Wildl. Conf. :330-338.

CUMP, G., R. W. DARROW, F. C. EDMINSTER and W. C. CRISSEY. 1947. The ruffed grouse. N. Y. S. Cons. Dept., Albany, N. Y.

DALKE, PAUL D. 1937. The cover map in wildlife management. Jour. Wildl. Mgt. 1(3-4):100-105.

———. 1941. Development of a statewide system of cover-mapping applicable to Missouri wildlife range. Jour. Wildl. Mgt. 5(1):103-107.

GRAHAM, SAMUEL A. 1945. Ecological classification of cover maps. Jour. Wildl. Mgt. 9(3):182-190.

GUTHE, OTTO E., and KENNETH C. MCMURRY. 1930. Cover mapping in southern Michigan. Papers of Mich. Acad. of Sci., Arts & Letters 14: 343-350.

LEOPOLD, ALDO. 1933. Game management. Chas. Scribner's Sons, New York.

WEBB, WILLIAM L. 1942. A method for wildlife management mapping in forested areas. Jour. Wildl. Mgt. 6(1):38-43.

WIGHT, H. M. 1934. The cover map and game census in pheasant management. Trans. 20th Amer. Game Conf. :329-333.

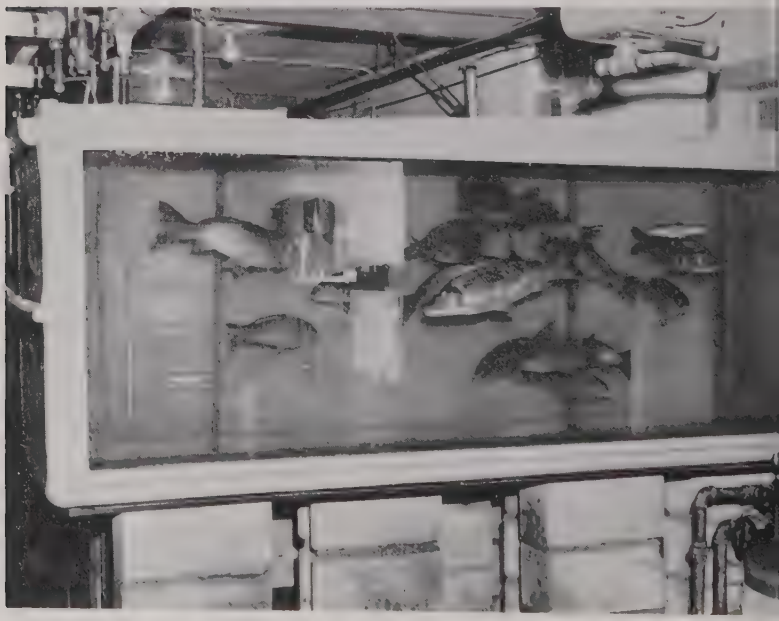
WILSON, H. L. and E. D. BERARD. 1952. The use of aerial photographs and ecological principles in cover type mapping. Jour. Wild. Mgt. 16(3): 320-326.

GENERAL NOTES

TEMPERATURE-CONTROLLED AQUARIUM TANKS[1]

Howard A. Loeb Aquatic Biologist
New York State Conservation Department

In order to carry out controlled experiments at the State Fish Labora at Livingston Manor (N. Y.) involving the effect of chemicals on fish, an cient and relatively cheap aquarium assembly was required. Criteria incl price, design and efficiency of tanks, glass front sealing, heating assen amount of maintenance, and effect of materials used on experimental fish introduced chemicals. Twelve 350-to 550-gallon tanks were constructed, e of which operates independently of the others. The entire assembly is conven and efficient, and may be adapted to general laboratory experimentation



Five hundred gallons of water are easily heated by aluminum grid at rea tank. Heating and water supply systems appear overhead. Fish are carp trout held at 65° F. (± 1.5°).

The tanks are constructed of fiber glass impregnated with plastic, and reinforced with ¾-inch pipe embedded in the top edge, front edges, and aro

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-9 The writer is indebted to Kenneth F. Stafford, New York State Con vation Department, for aid in design and assembly. Thanks are also du Christopher Coates, New York Aquarium, and Craig Phillips, Miami S quarium, for information concerning fiber glass tanks.

iberglass tanks are supported by concrete block pillars on a reinforced concrete oor 6 inches thick. Full tank weighs 3,000 to 4,500 pounds.

e middle on three sides. A 2-inch threaded drain is provided in one corner. n outlet drain and standpipe are inserted into this opening. Water flow in ch tank is controlled by an individual valve from an overhead system.

The smaller tanks measure 60 x 36 x 39 inches (inside dimensions), the tter being the height. Corners are rounded. Wall thickness ranges from ½ inch the sides to ¾ inch on the bottom. One long side is open and surrounded a 2-inch flange against which is fitted a ½-inch thick glass plate. A flat l along the bottom front edge supports the glass. The larger tanks are iden-cal except for length (96 inches) and glass thickness (¾ inch).

The flanges are lined with strips of rubberized tape, ⅛ inch thick, over nich is placed rubber pipe insulation, ¾ inch thick. Other materials such soft rubber or neoprene tubing would suffice. The plate glass is placed on rubber base on the sill and jammed tightly against the flange seal.

Water is run into the tank at a good volume both to fill it and to com-nsate for considerable leakage between the glass and the rubberized seal. eakage is almost stopped when the tank is half full. Complete filling exerts eat pressure on the glass, forcing it against the seal. Small leaks may con-nue for several days after which the seals are tightly compressed and bone-dry.

Emptying the tanks causes the glass to spring away from the seal, which nains somewhat compressed. To avoid this, waste products are syphoned or mped out.

Fiber glass-plastic tanks are strong, relatively light as compared with el, without sharp edges and non-corrosive. The material can be tapped d will hold screws. No maintenance is required. Cost is little more than at required for steel tanks.

Each tank is mounted on a ½-inch plywood sheet placed on 30-inch con-

crete block pillars. Because the glass is removable, the entire assembly can easily disassembled and transported without danger of leaks developing.

The basic heating system consists of a closed copper pipe running over tanks from a large oil burner and driven by a standard circulator. A grid of inch aluminum tubing is placed along the back of each tank and connec to the intake and return pipes above. Both sides of each grid may be regula by valves in case it must be removed.

The flow of water from the intake is controlled by a solenoid which turn is regulated by a thermostat with a variation of 1½° F. In this way, temperature of each tank can be independently maintained at any level betw 45° (temperature of water supply) and 80° F. The temperature range am different sections of each tank does not exceed 3° F. despite a lack of artifi circulation. The tank water may be raised from 45° to 65° F. in one ho and can be maintained at that temperature at a flow of several gallons minute.

SEX RATIOS OF THE RED FOX AND GRAY FOX IN NEW YOR

Samuel B. Linhart Coordinator, Wildlife Rabies Control Program
New York State Conservation Department

Layne and McKeon (1956) presented sex ratio data on the red fox a gray fox in New York as compiled from trapping records of the State ral control program for the years 1951 to 1953. They noted that for both spec a significantly greater number of adult males than females was trapped dur those years. Their data revealed that this preponderence of adult males greater during the January-April period than during the May-August or Sept ber-December periods of the year. They did not find a preponderence of ma among the pups.

Additional information on fox sex ratios has become available from trapping records of the rabies control program for the years from 1954 throu 1957. Average figures for this 4-year period show that more adult males th adult females were taken for both species. However, the ratios were more nea

Table 1. Sex Ratios of Red Foxes and Gray Foxes Trapped in N York State from 1951 to 1957

Year	Red fox (adult)			Gray fox (adult)			Red fox (pup)		
	Number		Sex	Number		Sex	Number		Se
	Male	Female	ratio§	Male	Female	ratio§	Male	Female	rat
1951*	1,745	1,247	139.9	255	137	186.1	715	754	9
1952*	2,607	2,184	119.4	274	214	128.0	795	774	10
1953*	1,090	909	119.9	136	116	117.2	698	815	8
1954	1,552	1,384	112.1	129	107	120.6	990	1,049	9
1955	709	668	106.1	91	71	128.2	454	519	8
1956	646	648	99.7	121	121	100.0	280	351	7
1957	1,062	1,031	103.0	78	90	86.7	616	663	9
Total	9,411	8,071	116.6	1,084	856	126.6	4,548	4,925	9

* Data from Layne and McKeon (1956).
§ Males per 100 females.

ıual than was the case from 1951 to 1953. The greatest seasonal disparity ·twеen the sexes among adult red foxes occured during the September-Decem-ər period. The numbers of adult gray foxes taken in each of the three seasonal ·riods (as used by Layne and McKeon) were believed to be too few for com-ıarison. The records for red fox pups agreed essentially with those of Layne ıd McKeon in that there was no preponderence of males. The data for gray x pups were not considered since too few specimens were taken.

Of interest is the fact that from 1951 through 1957 the sex ratios among dult foxes of both species, in general, became progressively more nearly equal Table 1). This is more noticeable for the red fox than for the gray fox. It ıs been generally assumed that the tendency for a greater proportion of males be trapped from a fox population is due to their having larger ranges and ·ing more prone to travel than the females, thus being more frequently taken. his asumption would not explain the apparent narrowing of the ratio during ıe 7-year period covered by the data presented here. An attempt was made to ɔrrelate this changing sex ratio with the areas trapped each year which, in ɔme cases, differed. However, no relationship was noted.

A rough estimate of fox population density for each year was made, for ıch species, by dividing the total trap nights expended each year by the num-ər of adult foxes trapped. There appeared to be no relationship between ɔpulation density and sex ratio.

LITERATURE CITED

AYNE, James N. and Warren H. McKeon. 1956. Some aspects of red fox and gray fox reproduction in New York. New York Fish and Game Jour. 3(1): 44-74.

A FISH-HOLDING DEVICE[1]

William H. Kelly Aquatic Biologist
New York State Conservation Department

An efficient device for holding large individual fish was constructed at e State Fish Laboratory at Livingston Manor (N. Y.). The need for such device became apparent when much difficulty was encountered in manually ɔlding carp prior to performing a force-feeding technique. Construction was rther suggested by another device made in Sweden for stripping salmon .indroth, 1956). The following description is general since individual dimen-ɔns, as well as details of construction and design, may vary according to the ecies and size range of fish to be held and the availability of suitable materials.

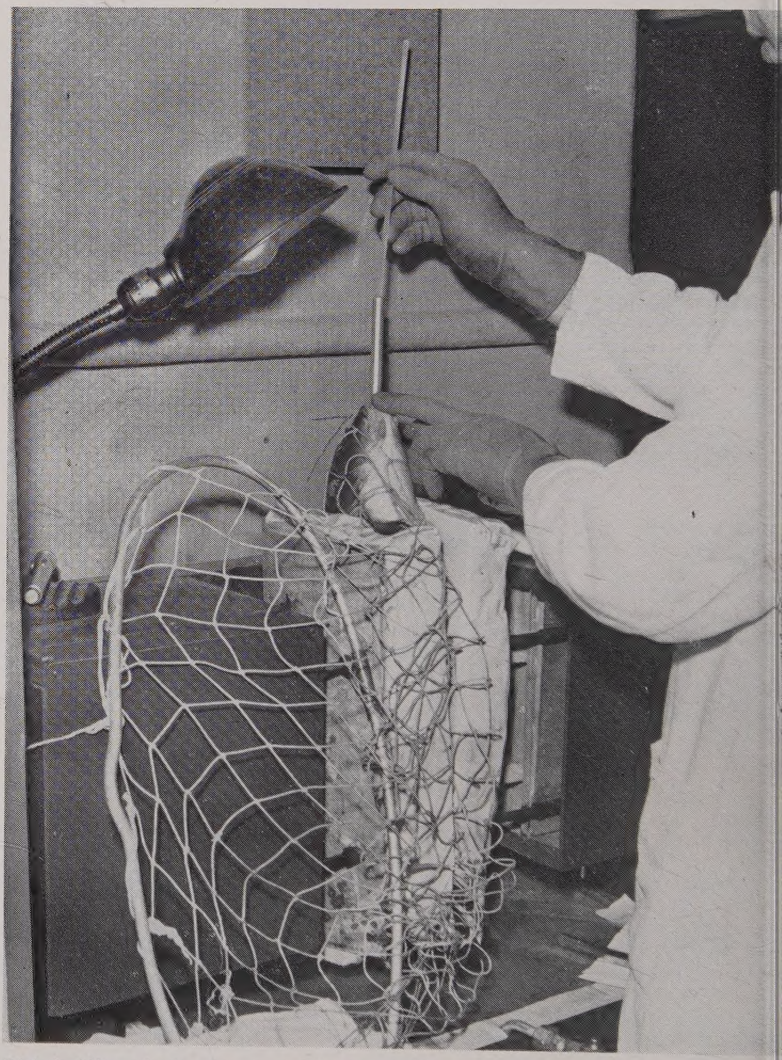
The device consists of a pair of movable jaws padded with foam rubber ıich are actuated by the controlled inflation of separate basketball bladders at occupy compartments behind either jaw. Each compartment has a freely ɔvable wall attached to the back of each jaw which allows for expansion ıd contraction of the bladder.

A return spring facilitates rapid release of the fish. Two parallel, greased ıd freely sliding rod and sleeve units were added as guides to eliminate ndding of the movable wall. The sleeves, which in this instance are metal pe, are attached to the frame of the device. One end of the rod is attached the jaws, while the opposite end is free to move within the sleeve.

Inflation of the bladders is effected by a push-button valve between the mpressed air supply and the lead-off lines to the separate bladders. A release lve is installed in the line in approximately the same location.

The advantages of this method of holding fish are: (1) the efficient hand-ıg of large fish is accomplished easily; (2) the chance of injury to the fish

[1] A contribution of Federal Aid in Fish and Wildlife Restoration Project F-9-R.



Fish-holding device in use with carp still in catching net. Note metal slee in which slide the rods that support padded jaws.

is considerably lessened since it is held gently but firmly by the foam rubber ja (3) only one operator is needed to perform the whole operation; (4) a c siderable time saving results. The latter should be emphasized. Since the dev has been in operation at this laboratory it has resulted in the saving of appro mately 10 man days per month.

With proper modification, such a device could be applied to many pha of fishery work where it is necessary to hold large fish. One practical ap

ion lies in using it as a tool for holding large fish for tagging purposes. If sirable, a portable fish-holding device could be made by using an auto tire mp of the push pedal type. Use of alternate types of pressure systems, such hydraulic or air cylinders, in place of air bladders might constitute a desir- e improvement.

It would also be possible to add a pivot at either end of the device to vide the operator with a 360-degree rotation of the unit, and therefore opportunity to hold fish in any position.

LITERATURE CITED

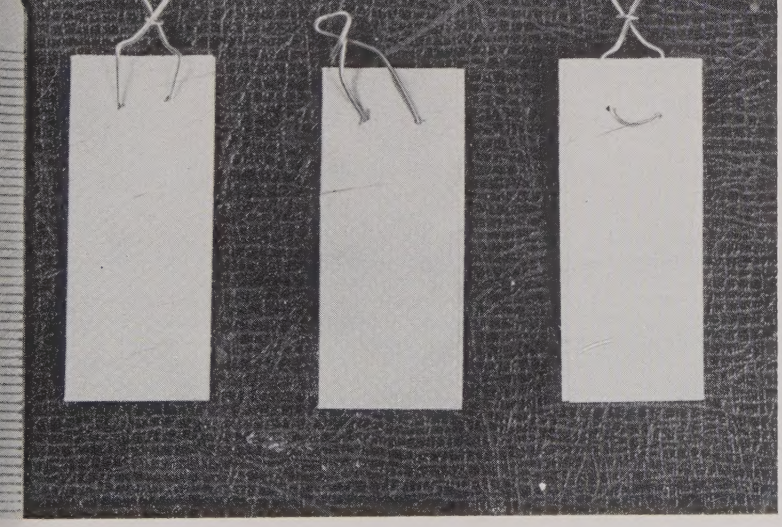
NDROTH, ARNE. 1956. Salmon stripper, egg counter and incubator. Prog. Fish-Cult. 18(4): 165-169.

INEXPENSIVE TAG FOR IDENTIFYING LABORATORY FISH

William H. Kelly Aquatic Biologist
New York State Conservation Department

Howard A. Loeb Aquatic Biologist
New York State Conservation Department

In experiments with carp in large aquaria (as many as 18 per tank) at Fish Laboratory at Livingston Manor (N. Y.), need developed for an icient means of marking that would facilitate the necessary quick notations ncerning the effects of chemicals on individual fish. It was found that laun- y tags would serve very well for this purpose. A steel spring clip with water- istent, colored paper attached, the tag is quickly placed on any of several ations—fin, mouth, gill cover, etc.



These tags may fall off after several days and always cause some irrita but these disadvantages have not hindered experimentation at this labora The brightly colored paper enables the experimenters to quickly identify in dual fish. The tags are available in a dozen colors and further breako can be achieved by cutting the paper, making pencil notations on the or placing them on different locations on the fish.

Cost is negligible (less than $3.00 per thousand) while the saving in n hours of work is considerable.

ERRATA

On page 163 of the New York Fish and Game Journal for July 1 in the portion of the table for male adults for 1950, the figures in the I dreds column for the last five counties were each transposed downward lines. The figure for Tioga County should read 630; that for Tomp County, 442; and so on. The line for "unknown" should be blank.

On page 175 of the New York Fish and Game Journal for July 1 the titles of the two authors were reversed; Haskell is fish hatchery forer